(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE

140 NASSAU STREET, NEW YORK

J. S. BONSALL, Business Manager.
F. H. THOMPSON, Eastern Representative

R. V. WRIGHT, E. A. AVERILL, } Editors.

FEBRUARY, 1909

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It has long been known in a general way that a brick arch will reduce smoke, but in many districts they were more trouble and expense than it was considered worth while to incur and largely disappeared after a short trial. The Chicago smoke inspection department, however, decided to find out for itself exactly to what extent they were useful in this way, especially when used in connection with blowers, and have carried out an elaborate series of tests in connection with the Chicago, Burlington and Quincy Railroad. The results as far as smoke is concerned are very convincing, as is clearly shown by the curves on another page. That this really means a saving that is worth while is shown by tests on the Lake Shore given in the same article.

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There would also seem to be a wide field for its use in steel passenger car construction, especially in connection with roof sheet joints, where expensive riveted construction is now necessary entirely for the purpose of tightness. The sheets in many places have to be small and the joints are numerous and must be water-tight.

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As is well known, the limited coal supply in foreign countries, with the accompanying high price, has led the railways there to give the most careful attention to fuel economy on locomotives. The most important feature, which is quite general in many parts of Europe, is to base the enginemen's wages almost entirely on the amount of coal they burn. Another method, which sooner or later will have to be considered in this country, is the use of low grade fuels that in their natural form are not suitable for locomotives. This is being, and has for some time been done, by means of briquetting and on many railways, particularly in France, briquets form a large proportion of the locomotive fuel.

While this is a subject that has been discussed more or less in this country, the condition of our natural resources has not reached a stage that makes it imperative to carefully investigate the question and it is only within the past few years that any really serious investigation or tests have been made with briquets from American coal. The organization of a fuel testing plant by the U. S. Geological Survey at the St. Louis Exposition included in its program an investigation of this subject, and while the study was first made in connection with stationary plants, later tests of briquets for locomotive use were made. The full report by W. F. M. Goss has just been issued by the Geological Survey and is quite largely reprinted in this issue.

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The results are very interesting and valuable, although many of the extravagant claims that have been made for briquets were

not proven. The tests were made by means of a comparison between a first rate grade of fuel in its natural state and the same fuel briquetted; the briquets included four or five varieties in two different shapes, the varieties differing in the amount of binder used. They were carried out on the Pennsylvania locomotive testing plant at Altoona and hence give results that are capable of accurate analysis and perfect confidence.

The conclusions reached by Dr. Goss are, that the evaporative efficiency of the boiler was increased by the use of briquets over natural coal and that they gave a marked increase in the efficiency of the locomotive and a slight reduction in the amount of smoke. They increased the facility with which an even fire over the whole area of the grate may be maintained. The briquets suffered little by handling; stood exposure to the weather very well and while there was no noticeable reduction in the amount of cinders and sparks the amount of heat lost in this manner was less. The tests made in actual service on several different railways showed them to be a satisfactory fuel, although there was no noticeable increase in the efficiency of the locomotive.

It is to be hoped that the experiments will be continued and that tests will be made with briquets from coal which in its natural state is not suitable at all for locomotive use, particularly the lignites of the far west.

CIRCULATION IN FIRE BOX WATER LEGS.

It seems to be pretty generally agreed that the failure of side sheets in wide fire box legs is due to a sluggish circulation in the water legs or at least that it can be cured by an increase in the rate of circulation. In the January issue we presented Mr. Seley's theory of the subject in that the circulation should impinge against the sheet and thus prevent the formation of a film of steam which would keep the temperature in the sheet much higher than is desirable. Elsewhere in this issue we give a discussion by Mr. Johnston on the same subject, in which he suggests the use of a circulating plate, which would form a division in the water leg of a wide fire box locomotive having inwardly inclined side sheets and prevent the cross currents and eddies now probably existing and caused by the steam tending to rise along the outside sheet. Such a plate would give a free passage for the downward circulation of the colder water along the outside sheet and, by making a narrower space for the rising of the steam along the inside sheet, would tend to increase the rate of circulation and thus prevent the formation of a film of steam on the side sheet by simply bringing the water to the sheet so rapidly as to prevent its formation. The fact that a scheme of this kind was discredited a long time ago in connection with very narrow water legs should not condemn it without trial under the present conditions. The idea is capable of application with small cost to the present locomotives and certainly is worthy of trial.

ALLOY STEELS.

The use of the so-called "alloy" steels has not been as general on railroad equipment in this country as would naturally be expected or as it has on foreign railways. This is particularly noticeable when a study is made of present day automobile construction where alloys of vanadium, chromium, nickel and manganese with steel or iron are widely employed. The service of an automobile in many ways is very similar to that of a locomotive, and if it pays to use these expensive materials there, it would seem to be advantageous to use them on railway rolling stock.

The foreign railways have recognized their value and have been using them for a number of years. A striking example of this is found in an order of large simple passenger locomotives recently built for a German railway in which the reciprocating parts were made so light as not to require any counterbalance in the wheels. Such tests as have been reported, particularly in connection with vanadium in cast iron car wheels, axles, frames, tires, etc., all indicate that there are great possibilities in this direction of decreasing wear, reducing weight, increasing safety and owering maintenance charges.

BEST METHOD OF TRAINING RAILROAD MEN.

The often discussed subject of the value of a college or university training as a preparation for a career in railroad work, particularly in the motive power department, again came up at the January meeting of the New York Railroad Club. Some of the old arguments pro and con were again advanced with the usual conviction on the part of the speakers and the usual result on the audience, viz., each one's ideas were influenced by the experience he, personally, had had with college men and while the vital importance of the subject was more or less generally recognized the conclusions were based on individual experience.

In view of the history of the development of mechanic arts of all kinds, it seems rather odd at first thought that it should be considered worth while to discuss this subject, or in fact that it should be capable of discussion at all. It would seem to indicate that there was an idea existent that education or learning is not valuable or worth while. Actually, however, that is not the point at all. All are agreed that the successful man must have both technical learning and experience and that he cannot be fully successful unless he is able to properly combine them and bring the combination to bear on every problem. The argument is really all on which of the two is the more important and should be given the preference. On the one side is advocated the crowding of the technical training all into a few years to be followed by an equally concentrated dose of practical experience, and on the other the obtaining of experience to be the principal object and the picking up of technical information to be by individual effort at odd times.

That the later method is not proving successful under present conditions is shown by the general introduction of shop schools, apprenticeship systems, trade schools, etc., which is now going on. That the former is faulty is indicated by the very fact that the subject is so often up for discussion.

These facts indicate the true condition. Neither method is fully successful and neither technical training nor experience is the more important or should be given the greater attention. They must be given equal care to attain the best results. This is beginning to be recognized at a few points and special courses are being given in mechanical engineering in the colleges in connection with practical work in the shops of manufacturing plants in the vicinity which alternate the school and shop work at equal intervals. The best railroad apprenticeship systems are doing the same thing to a less extent, giving greater emphasis to the shop training.

This movement is excellent and should be extended. While its success to a large extent depends on the location of the proper manufacturing shops in the same vicinity there are many places which offer the proper combination for its immediate installation. The course which seems to be the most successful requires attendance in the shop and school room on alternate weeks and includes the full curriculum of a technical course leading to the degree of mechanical engineer except the shop work and some of the experimental laboratory work usually included in these courses.

The application of this idea to a special railroad training is a little more difficult as very few colleges offering the properly trained teaching staff and laboratory facilities are located in the same locality as large railroad shops. The apprenticeship systems now being organized, however, give a first-class start, including, as they do, all the elements of this idea. A form of post-graduate course could probably be arranged with some of the technical schools which would produce the result desired with a comparatively small expenditure of time.

ARE RAILROAD CLUBS WORTH WHILE?

We regret that space does not permit reproducing in full the splendid address on this subject, made before the St. Louis Railway Club, by its president, J. J. Baulch. After considering in detail the aim and the work of the St. Louis Railway Club, he directed attention to some of the special features of the other clubs, among which the following may be mentioned:

New York Railroad Club has 1,400 members.

New England Railroad Club has a dinner before each meeting. Recently celebrated its twenty-fifth anniversary.

Northern Railway Club has a half-hour's entertainment each night, different districts having charge of the program for the various meetings.

Richmond Railway Club has special programs two or three times a year, the ladies being invited; also contributes to the Railroad Y. M. C. A.

Western Railway Club maintains a library and each year presents its members with a bound volume containing the proceedings for the year.

Central Railway Club endows a bed in the Brooks Hospital at Dunkirk and contributes to a home for newsboys and bootblacks in Buffalo.

Canadian Railway Club maintains a scholarship at McGill University.

St. Louis Railway Club in the past ten years has paid for the education of a young man at the Blees Military Academy at Macon and another at Purdue University. At present it has a young man at the University of Missouri.

"The railway club is educational. We are living in a rapidly advancing age; to-day's standards are discarded for something newer to-morrow, and the superintendent or traffic officer of the railroad to-day may be operating an airship line to-morrow; and, by attendance at our meetings, will keep abreast of the times, know what is going on in the world of thought and action, and be prepared, not surprised, at the many changes in methods of construction, maintenance, machinery, operation, accounting, and the legal attitude of the Government towards the railroads.

"The meetings of the club, the fraternal intercourse of man as man, employers and employees meeting on a common level, discussing those questions always arising in our work, offering suggestions for the betterment of the service makes for us the general democratic feeling which is the foundation of our success, and increases our ability to consistently perform our duties. That club men are frequently diffident about getting up and expressing themselves on the various questions cannot be gainsaid, but attendance at meetings often wears this diffidence off.

"It is only natural that we should make this organization the medium through which to communicate our ever advancing thoughts and ideas to each other, and to the railroad world generally, for the railway club here, as elsewhere, is an educator for the members and for those who peruse the proceedings, making the mingling together, the exchanging of views as to best methods of accomplishing good results in railway work, an educational feature tending to make the club a power for good and a permanent institution.

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"It, however, indicates, as we all know, that much friction exists between the various departments of the railroad. The operating and traffic departments do not agree, nor do the mechanical or the audit, or the road or the claim, or the repair or the inspection. They are often further apart—than if they were employed on rival lines. Bickering and crossfiring do not tend to the betterment of themselves or the service. Let these same men join a railway club, attend the meetings, write a paper occasionally, join in the discussion, take interest in the papers on topics covering departments other than their own, and I'll guarantee the practical elimination of department friction, and the upbuilding of the service.

"Here arises the time-honored excuse, too busy to attend, and entirely too busy to prepare a paper. That is the fellow we are after, the busy man. Glance over the 150 or more papers prepared for and read before this club since its inception, and see who has furnished, not only the papers, but from the discussion, who has read them. The answer is, the busy man. Again I say, the busy man is the fellow we are after, and as the railroad fraternity, and the men associated with railroad work and railroad supplies, etc., furnish but few drones, we are pretty sure to hit a busy man every time we shoot. Hence, I repeat, it's the busy man who prepares the papers and discusses them. The very fact that they are busy men shows that their interest, their thoughts are in the work, and they are ready to impart such information as they may, and to absorb all that they can, but the more railway clubs that we have and the larger the membership, the greater the good, and the more efficient the service.

"There is more or less misconception as to the value of the club. The acquaintance and association with men in every department of the railway and with supply men and others connected with the railroads in every day affairs, cannot be overestimated, and the mingling together removes friction, brightens up ideas, strengthens the membership generally, keeps up the interest in the meetings, and all to the end that we are better in every way for a membership in any railway club. Permit me here to quote from President Vreeland of the New York Club: 'It is conceded by practical railroad men of experience that there is no better school for the younger men in the service than the opportunity given by the various railroad clubs of the country for membership, which secures to them instruction from papers and discussions thereof.'"

The foregoing is to prove that railway clubs are worth while, and that there are not enough such organizations. With at most not over a dozen clubs in existence, some of them dormant, it does seem that more of the employees of the 227,000 miles of railroad in this country ought to get together, and that every city of any size should have a railway club, and railroad men attend it, not only for its value educationally, but for the social and fraternal features that are sure to arise, all of which go to make railway clubs worth while.

THE NEED OF GOOD ENGINE-HOUSE FACILITIES.—A generous appropriation for engine-house repairs saves money in the long run, by reducing the periods between shopping, insuring larger mileage, and giving a superior quality of service. The statistics of engine-house expense are usually based on the number of engines handled outward over a turntable, and an engine-house foreman sometimes, when urged to reduce that unit cost, does so to the detriment of the service by slighting some of the repairs.—*W. J. Cunningham before the New England Railroad Club.*

TRAIN DELAYS.—The report of the New York Up-State Public Service Commission for October shows that 77 per cent. of the steam railway trains operated in New York State were on time during this period, while the average delay of the remaining 23 per cent. of the trains was 26.3 minutes per train. Nearly two fifths of the aggregate delays for the month were due to trains waiting for trains on other divisions. The chief causes of delay and the percentage which each represented in the aggregate were: Engine failures, 5.6 per cent.; failures of other equipment, 1.7; wrecks, 6; unfavorable conditions of tracks, 2.1; waiting for trains on other divisions, 39.4; waiting for train connections with other railroads, 10.5; meeting and passing trains, 6.8; signals, 1.3; trains ahead, 7.1; waiting for orders, 4; train work at stations, 15.2; storms, 2; all other causes, 3.7.

RAILROAD CLUB NEWS

Canadian Railway Club (Montreal, Can.)—At the regular monthly meeting, held on January 5, a very interesting lecture, illustrated with stereopticon views, was given by Professor J. A. Bancroft, of McGill University, the subject being "Western Canada." The speaker explained how the prairies, mountains, etc., had been formed by the icefields and volcanic eruptions of pre-historic times and explained why certain localities and grounds were the best suited for certain crops.

The annual dinner of the club is scheduled to have been held at the Windsor Hotel on January 29.

At the December meeting the paper was presented by Mr. Gutelius on the subject of "Steel Rails in Canada." The author handled his subject in a very simple and interesting manner, pointing out how various difficulties, particularly in regard to the extremely low temperature found in Canada, had been overcome by the steel makers and how they had continually kept up with the increasingly difficult requirements of the railways. The specifications for rails from the Canadian Pacific Railroad were given in full. The discussion was general and included some interesting matter in connection with the effect of flat spots and counter-balance on rails.

At the same meeting a discussion of the paper presented at the November meeting, on "Freight Car Brakes" was continued.

The paper scheduled for the meeting of March 2 is on "Shop Time Keeping," by E. C. Lloyd.

Secretary, James Powell, P. O. Box 7, St. Lambert, near Montreal, Can.

Central Railroad Club (Buffalo, N. Y.)—At the meeting on January 8 a paper on "A Modern Method of Cutting Steel" was presented by Cecil Lightfoot. This paper explained briefly the method of cutting steel by means of a jet of oxygen, the material previously having been raised to a high temperature by means of an oxy-acetylene or other flame of great heat. A demonstration was given of the method described. The author states that no progress has been made in the cutting of cast iron by this process.

The annual banquet of the club was held at the Hotel Iroquois on the evening of the same date.

Secretary, H. D. Vought, 95 Liberty street, New York.

New York Railroad Club.—At the meeting held on January 15, J. E. Muhlfeld presented a paper on "The Education and Organization of Railway Engineering Labor," in which the subject of the proper training of young men for railroad work was considered most carefully in a broad way. The relations of the employer to the employee, as concerned railways, were discussed and the great value of harmony was pointed out. The discussion of the paper was largely along the lines of the value of college training for men in the motive power department. Mr. Basford drew attention to a new idea in the training of apprentices for industrial plants, which is beng tried by the University of Cincinnati.

The paper for the meeting of February 19 will be by Col. B. W. Dunn, chief inspector of the American Railway Association Bureau for the Safe Transportation of Explosives and other Dangerous Articles.

Secretary, H. D. Vought, 95 Liberty street, New York.

New England Railroad Club (Boston, Mass.)—At the December meeting, William F. Garcelon, of Newton, a member of the Massachusetts House of Representatives, presented a paper on "Railroad Men in Politics," in which he called upon railroad employees to take a more active participation in politics, and praised the various organizations, such as The Railway Business Association, for the work which they were doing, stating "that the creation of public sentiment by open and fair means is proper and justifiable and generally very effective. With a more active participation in politics by all classes of honest men our legislative bodies will be more conservative; they will better express the wishes of the people and the business interests will have less cause to complain of the evils of politics and legislation." During the discussion W. B. Leach explained in detail what the Railway Business Association was organized to do and called upon all supply men to join it and aid in the work.

The next regular meeting of the club will be held at Young's Hotel, Boston, February 9, when Henry C. Boynton of the John A. Roebling's Sons Co., of Trenton, N. J., will present a paper on "Steel Rails." Dinner will be served at 6:30 P. M., to be followed by the regular business session at 8 P. M.

Secretary, George H. Frazier, 10 Oliver street, Boston, Mass.

Northern Railroad Club (Duluth, Minn.)—Next meeting Saturday evening, February 27. The paper will be by W. H Siedel, chief dispatcher Great Northern Railway, Superior, Wis., on the subject of "Dispatching of Trains by Telegraph or Otherwise."

At the December meeting the discussion of Mr. Seddon's paper on "Locomotive Boiler Washing" was continued. All of the members participating spoke most highly of the hot water washing out system. Those who had experience claimed great savings in the mater of time, as well as reduction in boiler repairs. The paper of the evening was on "Steel and Concrete Ore Docks," by W. A. Clark. The paper briefly touched upon the most important features in ore dock construction and gave a short description of a new dock recently built at Two Harbors. A topical discussion on the subject of "Causes of Sharp Flanges on Driving Tires" was briefly considered.

Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

Railroad Club of Pittsburg.—At the meeting of February 26 a paper will be presented by R. G. Manning, engineer, American Bridge Company, Ambridge, Pa., on the subject of "Steel Railroad Bridges."

At the January meeting Wm. Elmer presented a paper on the subject of "Steam Engine House Auxiliaries." The author begins with an engine which has just finished its run and is on its way to the ash pits and follows it through each step until it is again coupled to an out-going train. Each feature of work on the engine is clearly and carefully treated and the best methods of doing the work, in the author's estimation, are illustrated. The paper is filled with valuable suggestions for expediting terminal work and was quite extensively illustrated.

At the January meeting resolutions were passed complimenting the Railway Business Association on its work for better sentiment on the part of the public toward the railroads and pledging the hearty support of the club to the movement.

Secretary, C. W. Alleman, General Offices, P. & L. E. R. R., Pittsburg.

Southern and Southwestern Railway Club (Atlanta, Ga.).—At the quarterly meeting, held January 21 at the Piedmont Hotel, the subject of "Head Lights" was discussed. The next meeting will be April 15, subject not yet announced.

Secretary, A. J. Merrill, Prudential Bldg., Atlanta, Ga.

St. Louis Railway Club.—At the next meeting, on February 12, W. E. Harkness will present a paper on the subject of "Train Dispatching by Telephone," which will include an actual demon-

stration of the workings of the selector in connection with the telephone.

The January meeting was very largely attended and was greatly entertained by George A. Post, president of the Railway Business Association, who spoke on the subject of "The Smile Combine."

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

Western Railway Club (Chicago).—At the next meeting, February 16, a paper will be presented by R. B. Dole, assistant chemist of the Water Resource Branch of the U. S. Geological Survey. This department has been making a mineral analysis of surface water all over the U. S. and this paper will discuss the waters in the middle-western states through which the roads running out of Chicago are located.

Mr. McAulliffe in his paper on "The Purchase of Railway Fuel Coal" made a plea for some provision which would prevent the present biennial shut-down of the mines, caused by the readjustment of labor conditions in the mines every two years and usually occupying about ten weeks. Previous to this shutdown extra efforts are put forward by the miners and a stock of coal has accumulated and incidentally he acquires sufficient money to tide him over the strike period. The paper suggested the formation of an arbitration committee and law similar to that now in force in Canada, which would prevent this shutdown. It contains some very striking figures on the consumption of coal by railways in the U. S. and made a strong argument for basing fuel contracts on quality and introduce competition rather than make them a reward for commercial tonnage. The mechanical and fuel departments should have a closer relation.

The subject was not given a very extended discussion.

Secretary, J. W. Taylor, 390 Old Colony Bldg., Chicago.

FULTON BILL DANGEROUS TO RAILROADS.

HOW YOU CAN HELP.

So many are asking concerning the Fulton Bill as to indicate the importance of an explanation of the proposed enactment, giving its nature and its possible effects if made into a law.

Under the present laws a railroad, wishing to increase rates may file the new rate schedule with the Interstate Commerce Commission and after thirty days, under normal conditions, the new rates will go into effect. Should a shipper complain of unfairness of a rate to his interests, the case comes before the Interstate Commerce Commission for investigation and adjudication. Meanwhile, the shipper is paying the advanced rate and when the case is decided, if this rate is judged to be unfair to the shipper the railroad refunds to the shipper the difference between the amount he has paid and the amount the Interstate Commerce Commission judges that he ought to have paid.

This method seems, all things considered, to be most satisfactory and equitable. Shippers complain because in the event of a new rate case being decided adversely to the railroad, the shipper's funds may be tied up pending a trial of the case. The Interstate Commerce Commission is a busy body of men and it naturally requires time to investigate complicated cases of rates, frequently rendering the process of decision rather slow. The shipper, however, loses no money by the delay.

The Fulton Bill would change all this. It would reverse matters with respect to the operation of a new rate. In its original form the bill provides that a shipper may protest against a new rate and prevent it from being put into effect until the new rate has been investigated by the Interstate Commerce Commission, and judged to be fair. This would mean that shippers could through unlimited accumulation of protests prevent a railroad indefinitely from obtaining from the commission the right to put a given increase into effect, or even a hearing. If this principle should be applied to a merchant it would deprive him of any voice in the price which he should charge for his goods. Senator Fulton was impatient concerning the delay in reporting his bill from the Interstate Commerce Committee of the Senate, and on January 6 that committee reported it unfavorably.

Mr. Fulton, undoubtedly realizing the difficulties in securing the passage of the bill, has amended it, putting it in such form as to be more likely to become a law The most important change is to make it discretional with the Interstate Commerce Commission whether or not it will allow the new rate to go into effect pending the decision of the Commission as to whether or not it is reasonable.

The amendment also carried into the bill a new feature which looks in the general direction of promoting pooling by the railroads, under the control of the Interstate Commerce Commission.

The bill is now upon the calendar of the Senate and with the amendment is likely to be brought up for debate. This bill should not become a law for the following reasons:

In the interests of all concerned, the investor, the shipper and the public, it is necessary that the railroads should have the right to raise a rate which is found to be too low, subject to protest by a shipper, adjudication by the Commission, and refund by the railroad in case of an adverse ruling, because such a method is just, right and fair to all concerned.

This bill, becoming a law, would prevent the increase of a rate upon one protest or without a protest until the busy Interstate Commerce Commission reaches its decision.

Such a law would swamp the Commission, which is already hopelessly behind in its work. Before a rate could be decided the conditions might change and the decisions in such delayed cases, while they might be fair on the main issue, might lead to injustice because they might not apply to the changed conditions.

Such delays would render the rate problem exceedingly inelastic, and the difficulty of raising a rate would have the effect of preventing the roads from ever making a reduction.

Rate discrimination, covering large sections of the country, might result from such a law, because of the certainty that rates would not be reduced anywhere, whereas it would be discretionary with the Commission whether or not rates should be raised.

Our national legislators can probably be induced to give the railroads a fair hearing before voting upon this bill, if all who appreciate the situation will at once write their Senators and Representatives requesting intelligent study of its probable effects upon the people. Will you who read these paragraphs write your Senators and Representatives at once before you lay this paper aside? Will you also notify the Railway Business Association (No. 2 Rector street, New York City), that you have done so? In writing about the Fulton bill please also urge calmness and fair-mindedness in the consideration of all other measures affecting public interests through the transportation interests.

The bill has aroused vigorous protest from many interests. Telegrams and letters were poured in on the Senate Committee from financial, labor and industrial leaders. The Railway Business Association on January 5 sent about 250 telegrams from its members and others in sixteen States, and this influence is said at Washington to have had a potent effect. The next day the adverse report was made, the vote in committee having been 6 to 5.

COMPARATIVE TESTS OF RUN-OF-MINE AND BRIQUETTED COAL ON LOCOMOTIVES*

W. F. M. Goss.

INTRODUCTION.

For the purpose of procuring data that could be used in estimating the value of the briquetting process as applied to American fuels, the United States Geological Survey, in co-operation with other interests, began in 1904, at the Louisiana Purchase Exposition, certain experiments involving the production and use of bituminous-coal briquets. It installed at St. Louis, and later at Norfolk, machines for the manufacture of such briquets, and the output of these machines has been tested in locomotive service on several different railroads in comparison with natural fuels. An elaborate and carefully executed series of tests involving the use of natural coals and of briquets made from the same coal, previously crushed, has been carried out on a locomotive mounted at the testing plant of the Pennsylvania Railroad Company at Altoona, Pa.; and some preliminary experiments involving the use of briquets in marine service have been made in connection with one of the Government's torpedo boats. A description of these tests is presented herewith. The results sustain the following general conclusions:

1. The briquets made on the Government's machines have well withstood exposure to the weather and have suffered but little deterioration from handling.

2. In all classes of service involved by the experiments, the use of briquets in the place of natural coal appears to have increased the evaporative efficiency of the boilers tested.

3. The smoke produced has in no test been more dense with the briquets than with coal; on the contrary, in most tests the smoke density is said to have been less when briquets were used.

4. The use of briquets increases the facility with which an even fire over the whole area of the grate may be maintained.

5. In locomotive service the substitution of briquets for coal has resulted in a marked increase in efficiency, in an increase in boiler capacity, and in a decrease in the production of smoke. It has been especially noted that careful firing of briquets at terminals is effective in diminishing the amount of smoke produced.

COMPARATIVE TESTS OF LLOYDELL COAL AND BRIQUETS.

The tests of Lloydell coal and briquets here reported were made under the direction of A. W. Gibbs, general superintendent of motive power of the Pennsylvania Lines, by E. D. Nelson, engineer of tests, at Altoona, Pa.

PURPOSE OF THE TESTS.

Many low-volatile coals, such as those mined in the vicinity of Johnstown, Pa., are semi-smokeless and therefore very desirable for use in locomotives at or near terminals; nevertheless, on account of their low evaporative efficiency, they have not been found altogether satisfactory when used as locomotive fuel. Their tendency to disintegrate rapidly on the grate during combustion causes large quantities of cinders and sparks of high calorific value to be discharged. These cinders accumulate in the smoke-box of the locomotive, obstruct the draft on the fires and reduce the capacity of the boiler. The investigation here reported, therefore, was undertaken to determine in what measure, if any, the process of briquetting will serve as a remedy for these defects and to discover the effect of the process on efficiency and capacity.

COAL TESTED.

The coal selected for the tests was taken from a mine working the Lower Kittanning coal bed near Lloydell, Pa., on the South Fork branch of the Pennsylvania Railroad. This coal was practically the same as that mined in the Scalp Level district of Pennsylvania, which was used in all the locomotive tests made by the Pennsylvania Railroad Company at the Louisiana Purchase Exposition in 1904. Its characteristics as a locomotive fuel were therefore well known. The Lloydell coal is a very friable, low-volatile, bituminous coal, and the carloads selected for the tests consisted of run-of-mine. The coal was exposed to the weather for thirty days on the way to the St. Louis testing plant, before being briquetted. It showed but little change due to this exposure except a decided increase in moisture, which, however, was eliminated in the briquetting process.

BRIQUETS TESTED.

The briquets tested were of two sizes, and the amount of binding material in them ranged from 5 to 8 per cent. The larger size, called in the tests "square," was rectangular in form, about 3 by 4¼ by 6¾ inches, with slightly rounded corners, and weighed about 3½ pounds. The smaller size of briquet, called "round," was cylindrical with convex ends, had a diameter of about 3 inches and a length over the convex ends of 2 inches, and weighed about one-half pound.

The binding material in all the briquets was water-gas pitch. This material was furnished at the briquetting plant of the United States Geological Survey, in St. Louis, at $9 per ton, or 0.45 cent per pound. The least amount in binding material that would make perfect briquets was found to be 5 per cent. of the weight of the coal. The cost of the binder in one ton of the 5 per cent. briquets was therefore 45 cents.

The cost of briquetting, including all charges, is estimated to be about $1 per ton of briquets; that is, the briquetting added approximately $1 per ton to the cost of the coal. The briquets were made, however, in an experimental plant, and the price is for this reason probably not so low as if they had been made on a much larger scale.

The briquets were made by the fuel-testing plant of the United States Geological Survey at St. Louis. After the coal was made up into briquets it was returned to the locomotive testing plant at Altoona, Pa., for the tests. The method of making the briquets is described in detail in previous reports of the Geological Survey.* In this process the binding material is mixed with the crushed coal, the mass is softened by contact with steam as it passes to the briquetting press, and the briquet is finally formed in a compressing machine.

The locomotive used for all tests was a simple Atlantic type passenger locomotive of the Pennsylvania Railroad Company's class E 2a.

TEST CONDITIONS.

In order to obtain results covering all practical rates of evaporation up to the limit of the boiler capacity, tests were made with each style of briquets and with the natural coal under the following conditions of running: First, a low evaporation test at 80 revolutions per minute and 15 per cent. cut-off; then a higher evaporation test at 120 revolutions per minute and 20 per cent. cut-off; next a still higher evaporation test at 160 revolutions per minute and 25 per cent. cut-off; and finally a test made at the maximum possible evaporation. With the briquetted coal this maximum-capacity test was at 200 revolutions per minute and 32 per cent. cut-off. Four or at most five tests were thus sufficient to cover the range of boiler capacity.

EVAPORATIVE EFFICIENCY.

Figure 1 shows the equivalent evaporation per pound of dry

* Extracts from Bulletin 363 of the United States Geological Survey.

* Report on the operation of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, St. Louis, Mo., 1904: Prof. Paper No. 48. See also Bulletins 290, 332, and 343

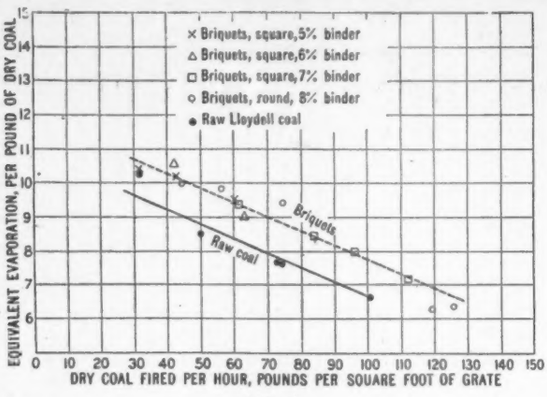

× Briquets, square, 5% binder
△ Briquets, square, 6% binder
□ Briquets, square, 7% binder
○ Briquets, round, 8% binder
● Raw Lloydell coal
Briquets
Raw coal
EQUIVALENT EVAPORATION, PER POUND OF DRY COAL
DRY COAL FIRED PER HOUR, POUNDS PER SQUARE FOOT OF GRATE

FIG. 1.

coal plotted against the rate of combustion. The figure represents a comparison under the same test conditions between the natural Lloydell coal and the same coal briquetted. It shows that a well-defined improvement in the evaporation per pound of fuel is obtained by briquetting. Figure 2 shows the same relation as Fig. 1, expressed in per cent.

In a comparison made on the basis of evaporation per square foot of heating surface, the better results for briquetting are further emphasized. The maximum evaporation possible with the natural Lloydell coal was 16 pounds per square foot of heating surface per hour, but with the same coal briquetted the evaporation was more than 19 pounds.

The ultimate measure of locomotive efficiency is expressed, of course, in terms of coal per dynamometer horse-power hour. This value, plotted against dynamometer horse-power, is given in Fig. 3, which shows that whatever may be the power devel-

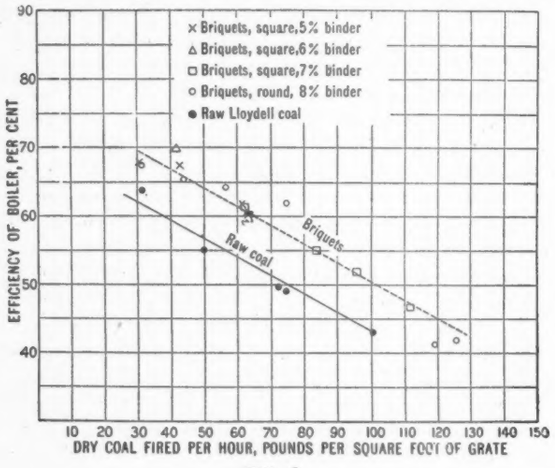

× Briquets, square, 5% binder
△ Briquets, square, 6% binder
□ Briquets, square, 7% binder
○ Briquets, round, 8% binder
● Raw Lloydell coal
Briquets
Raw coal
EFFICIENCY OF BOILER, PER CENT
DRY COAL FIRED PER HOUR, POUNDS PER SQUARE FOOT OF GRATE

FIG. 2.

oped, the briquets give the greater efficiency, but that when the power is extremely low or extremely high the difference is small. At the point of maximum efficiency the difference amounts to nearly 35 per cent. It should be remembered, however, in dealing with dynamometer horse-power that several variable factors, such as machine friction and engine efficiency, are introduced into the equation; and that the only true comparison to disclose the relative values of different fuels is that which is based on boiler performance alone.

CINDERS.

There appears to be little or no difference in the weight of cinders obtained from the natural coal and the briquetted coal at any particular rate of combustion. The sparks from the stack, when the locomotive was fired with briquets, were in the form of flakes of a size considerably larger than those discharged when coal was fired.

The calorific value of the cinders collected in the smoke-box and the sparks discharged from the stack is, in general, higher for the natural coal than for the briquetted coal. That is, the heat loss due to the sparks and cinders is greater for the natural coal, though the quantities in pounds of cinders may be the same.

The amount of heat lost in the form of cinders and sparks, expressed as a percentage of the total heat supplied, is shown graphically by Fig. 4, in which the solid line represents the average cinder and spark loss for raw Lloydell coal at varying rates of combustion, and the broken line the same loss for the briquetted Lloydell coal. The points representing the former lies extremely close to the average line, but those representing the latter do not fall in such close alignment. It is a fact worthy of note, however, that those points which represent tests with briquets

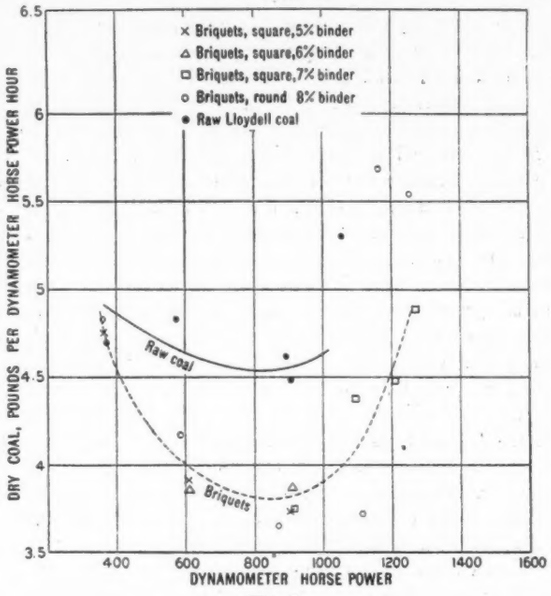

× Briquets, square, 5% binder
△ Briquets, square, 6% binder
□ Briquets, square, 7% binder
○ Briquets, round 8% binder
● Raw Lloydell coal
Raw coal
Briquets
DRY COAL, POUNDS PER DYNAMOMETER HORSE POWER HOUR
DYNAMOMETER HORSE POWER

FIG. 3.

having the larger percentage of binder generally fall below the average line, whereas those for the smaller percentage of binder generally fall above the average line. The curve therefore shows that, (a) the loss due to cinders and sparks is greater when raw coal is used than when briquets are used, and the difference increases as the rate of evaporation increases; (b) the loss due to cinders and sparks decreases slightly as the percentage of binder used in the briquets is increased.

SMOKE.

The density of smoke from the locomotive was compared with the Ringelmann charts. These charts are usually designated as follows: No. 0, no smoke; No. 1, light gray; No. 2, darker gray; No. 3, very dark gray; No. 4, black; No. 5, very black.

In Fig. 5 the smoke density is plotted against boiler capacity, and average lines are drawn through points representing tests

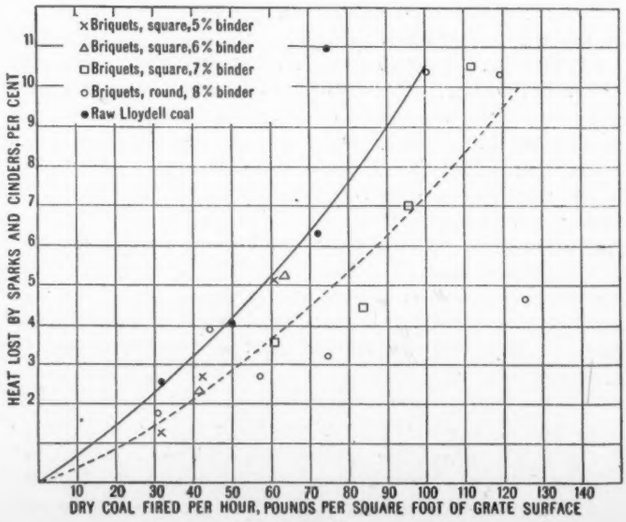

× Briquets, square, 5% binder
△ Briquets, square, 6% binder
□ Briquets, square, 7% binder
○ Briquets, round, 8% binder
● Raw Lloydell coal
HEAT LOST BY SPARKS AND CINDERS, PER CENT
DRY COAL FIRED PER HOUR, POUNDS PER SQUARE FOOT OF GRATE SURFACE

FIG. 4.

with raw coal and briquets with 8, 7, and 5 per cent. of binder. As there are but two points representing tests with briquets having 6 per cent. binder, and as their position seems to be contradicted by the position of the other points, no line has been drawn through them. The curves show that the smoke density is nearly constant for all capacities under 90 per cent. of full load, but that for capacities beyond this point the density increases rapidly. It appears that for all tests with briquets the density of the smoke is less than for corresponding tests with raw coal, but more smoke is produced with briquets having 8 per cent. binder than with those having 5, 6, or 7 per cent. Whether this fact is to be explained by the varying amounts of binder used or by the difference in size and shape is a question. However, as the binding material employed consists largely of volatile matter, it is reasonable to suppose that the varying amounts used in the several briquets cause the varying density of the smoke shown in Fig. 5.

SMOKE DENSITY IN INTERMITTENT RUNNING.

At the end of test 13, with the locomotive standing, the blower was put on, and after two minutes the smoke cleared. Immediately after the close of test 14, with a very heavy fire, the engine was again started at a slow speed and with partly open throttle. With these conditions of running, the smoke cleared entirely after eighteen minutes. These conditions are not dissimilar to the intermittent operation to which a locomotive is subjected as it enters a terminal, and the results show the degree

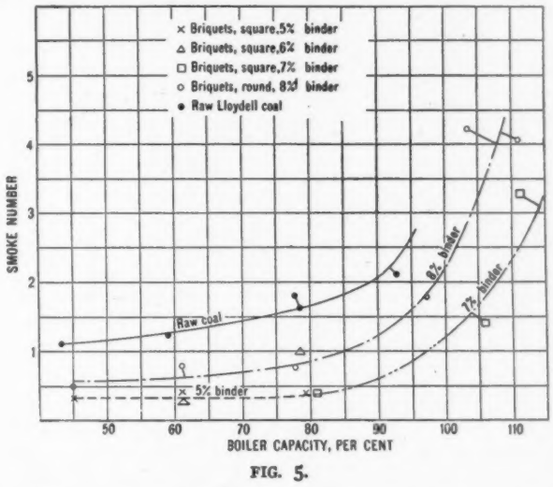


FIG. 5.

of smoke control which the use of briquets makes possible under adverse conditions.

BEHAVIOR OF COAL AND BRIQUETS DURING COMBUSTION.

Briquets of both small and large size were fired with the ordinary shovel and were handled in much the same manner as coal. In all tests they were fired alone without mixing with coal. It was not necessary to break the briquets in order to handle them readily with the ordinary scoop shovel, and the unbroken briquets burned freely and completely. They disintegrated slowly from the heat of the flame and became more or less porous as they swelled and opened under the action of the heat.

In the process of starting a fire with briquets no difficulty was experienced, the ordinary blower arrangements at the engine house being sufficient. The natural coal was finely divided when fired and did not form so open a mass in the fire-box as the briquets. Much of the finer portion was drawn, unburned, through the tubes by the force of the draft.

EFFECT OF HANDLING AND WEATHERING ON BRIQUETS.

To observe the effect on briquets of exposure to the weather, a number of the round and square briquets were placed on the roof of the testing plant. After four months of exposure for the round and three months for the square briquets, no change whatever from their original condition was noticed. They appeared to be entirely impervious to moisture and were still firm and hard.

The briquets were little affected by handling. They were loaded at St. Louis in open gondola cars and shipped to Altoona, where they were unloaded by hand and stacked. They were handled a third time in taking them to the firing platform of the test locomotive. After these three handlings they were still in good condition, very few were broken, and the amount of dust and small particles was practically negligible.

CONCLUSIONS.

The results of the tests justify the following conclusions:

(*a*) The evaporation per pound of fuel is greater for the briquetted Lloydell coal than for the same coal in its natural state. This advantage is maintained at all rates of evaporation.

(*b*) The capacity of the boiler is considerably increased by the use of briquetted coal.

(*c*) Briquetting appears to have little effect in reducing the quantity of cinders and sparks; the calorific value of these, however, is not so high in the briquetted as in the natural fuel.

(*d*) The density of the smoke with the briquetted coal is much less than with the natural coal.

(*e*) The percentage of binder in the briquet has little influence on smoke density.

(*f*) The percentage of binder for the range tested appears to have little or no influence on the evaporative efficiency.

(*g*) The expense of briquetting under the conditions of the experiments adds about $1 per ton to the price of the fuel, an amount which does not seem to be warranted by the resulting increase in evaporative efficiency.

(*h*) With careful firing, briquets can be used at terminals with a considerable decrease in smoke.

(*i*) The briquets appear to withstand well exposure to the weather, and suffer very little deterioration from handling.

COMPARATIVE ROAD TESTS OF COAL AND BRIQUETS.

ATLANTIC COAST LINE RAILROAD.

In the following table are presented the results of comparative tests of run-of-mine New River coal and of briquets of the same fuel, made in December, 1907, on a locomotive in the regular passenger service of the Atlantic Coast Line Railroad. These tests were conducted under the supervision of R. E. Smith, general superintendent of motive power of the railroad, in co-operation with the United States Geological Survey. Sixteen complete test trips were run between Rocky Mount and Wilmington, N. C., with the same engine, crew, and trains. An equal number of tests were made with run-of-mine coal furnished by the railroad company and with round and rectangular briquets made at the Geological Survey fuel-testing plant at Norfolk, Va., from the same coal, with 6 per cent. of water-gas pitch binder.

	Coal.	Briquets.
Number of test trips	16	16
Total pounds consumed	172,700	161,980
Average pounds consumed per trip	10,794	10,124
Average tons consumed per trip	5.387	5.062
Total engine miles	1,984	1,984
Total car miles	10,912	12,896
Pounds consumed per car mile	15.8	12.5
Average cars per train	5.5	6.5

It is reported that from a practical standpoint the briquets thus tested were very satisfactory. Their use was found to eliminate all black smoke. No objectionable clinker was formed and the fuel seemed to burn completely.

CHESAPEAKE AND OHIO RAILWAY.

In December, 1907, the United States Geological Survey cooperated with the Chesapeake and Ohio Railway in making a series of comparative road tests of the performance of run-of-mine coal and briquets of the same coal on locomotives in regular service.

No attempt was made in these tests to make careful measurements of fuel and water; however, during the tests the following facts were developed. The briquets ignited freely, made an intensely hot fire, and when the engine was working emitted very little smoke. It was found that a comparatively heavy fire could be carried without danger of clinkering. Few ashes were left in the fire-box or ash pan, and the cinder deposit in the front end was small. The results do not show that any apparent improvement in evaporative efficiency was obtained by the use of briquets, as compared with that obtainable from the natural fuel.

FAILURE OF SIDE SHEETS ON WIDE FIREBOX LOCOMOTIVES

W. E. JOHNSTON.

It appears to be the general opinion that the trouble from cracked side sheets in wide fireboxes is due to defective circulation. Assuming this to be true, it must be the result of one of two causes, viz.: excessive resistance to the circulation or the lack of a sufficient impelling force. The wide water legs now in use offer much less resistance to a free circulation than the narrow ones used on old narrow firebox boilers which gave no trouble in this respect. The lack of a sufficient impelling force must therefore be the true reason for the defective circulation.

Steam liberated in a body of water tends to move vertically upwards. In the water leg of a wide firebox boiler as shown

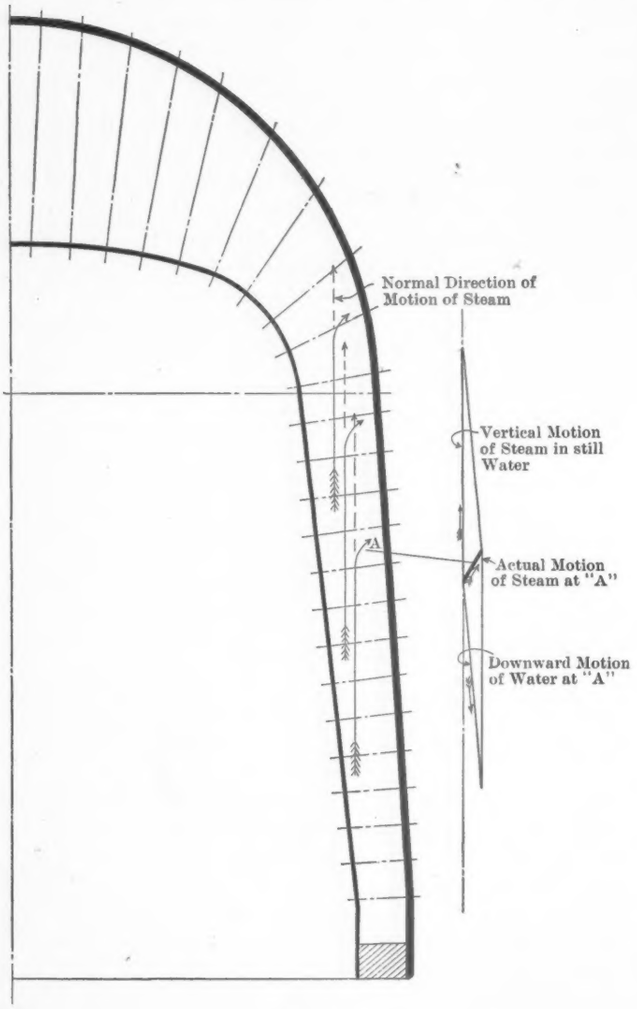

Normal Direction of Motion of Steam
Vertical Motion of Steam in still Water
A
Actual Motion of Steam at "A"
Downward Motion of Water at "A"

FIG. 1.

in Fig. 1, this movement carries it towards the outside sheet as indicated by the arrows, the actual movement of the steam (indicated by the solid arrows) being a combination of this natural vertical tendency and the downward motion of the water near the outside sheet. If the water near the outside sheet be at a sufficiently low temperature the steam will be condensed and will give up its latent heat of evaporation. By this action, all the water in the leg tends to become of uniform temperature. If the water near the outside sheet is not cool enough to condense all the steam the remainder will rise along the sheet in opposition to the desired direction of circulation. In either case, the impelling force which should cause the general circulation up the fire sheet and down the outside sheet is very materially reduced. To produce a rapid circulation, the heat and steam must be kept in the water close to the fire sheet, so that there may be as great a difference as possible between the specific gravities of the water near the fire sheet and that near the outside sheet.

With a sluggish circulation, the water at the fire sheets evidently reaches a much higher temperature than with a brisk circulation, and the amount of steam liberated in the water leg probably varies nearly inversely as the rapidity of the circulation. The pressure seven feet below the surface of the water in a boiler carrying steam at 200 pounds pressure is about 2½ pounds greater than at the surface, and the temperature at which steam will be formed at this increased pressure is about 1 degree

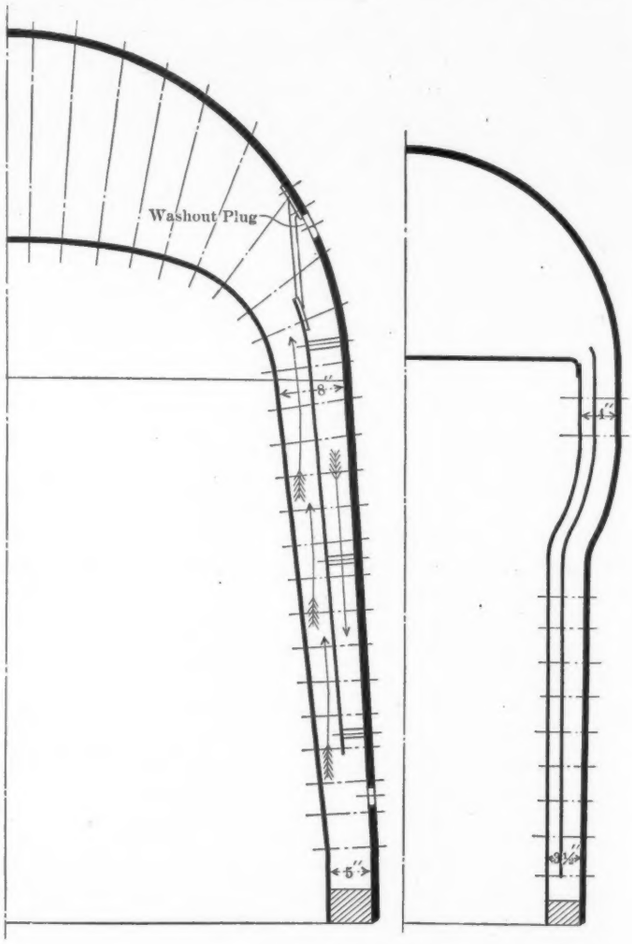


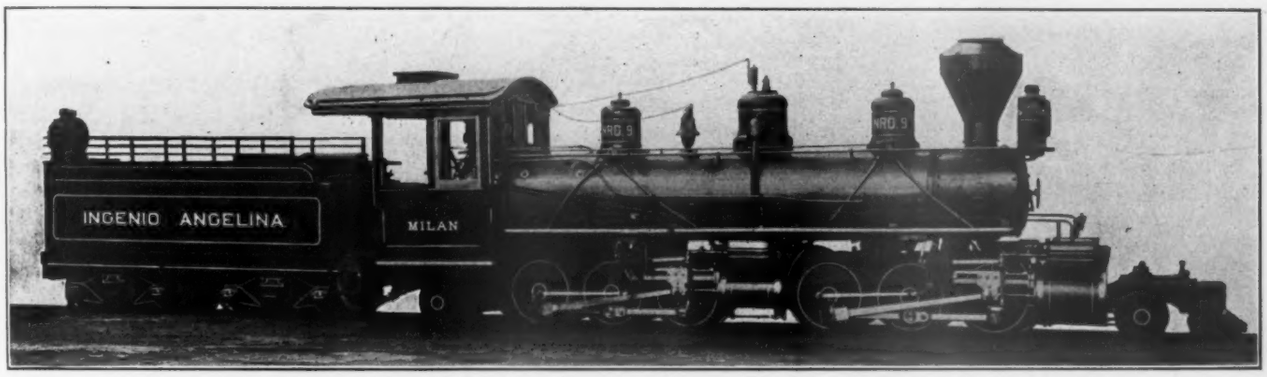
FIG. 2.

Fahr. higher than that of steam at 200 pounds pressure. Assuming some rate for the transmission of heat through the fire sheet to the water, the calculation of the point at which the water will reach the boiling temperature as it flows up the fire sheet at assumed velocities shows at once that the point at which steam begins to form on the fire sheet moves downward rapidly as the velocity of the circulation is diminished. With the sluggish circulation existing in the water leg, shown in Fig. 1, it is probable that steam begins to form at such a low point that the sheets are exposed to the direct flame with nothing but steam to protect them, leading inevitably to burnt and cracked sheets.

The solution of the difficulty may lie in the old so-called "circulating plates" used many years ago, but abandoned on account of trouble from clogging up, etc. With the new designs of boilers using wide water legs, there seems to be ample room for such a plate without danger of clogging. Fig. 2 shows a plate in the boiler shown in Fig. 1. This may be suspended independently of the staybolts, if desired, with holes sufficiently large so as not to interfere with their free deflection with the movements of the fire sheet. A little steam might leak through these holes, of course, but the amount would be so small as to be negligible. With this plate the steam leaving the surface of the fire sheet would be compelled to follow its proper course upward on the inside of the plate and the water on the outside of the plate would be kept cool and free from steam and therefore heavy until it got to the proper point near the bottom of the water leg, from which point it would be drawn up between the fire sheet and the circulating plate.

By stopping off the circulating plate at the top where the fire sheet begins to curve and below the washout plugs usually located even with the crown, any possibility of trouble from inability to thoroughly wash out would be avoided. As no steam will be formed very near the bottom of the water leg with a brisk circulation, the bottom of the circulating plate may be kept some distance up from the mud ring, say 18 inches, depending on the inward slope of the sheets.

Figure 3 shows a circulating plate applied to the boilers of some standard engines built in 1882. It is evident that the trouble experienced with the plates in these or similar boilers is no indication that the plate as applied in Fig. 2 would not be entirely satisfactory. On the new designs of wide firebox boilers where the steam and hot water by following their natural tendency to rise vertically, mix with the water which should stay cold, the case is entirely different, especially as the wide water legs give ample space for the application of the plate.



NARROW GAUGE MALLET ARTICULATED TYPE LOCOMOTIVE.

The locomotive shown in the accompanying illustration has recently been finished by the Baldwin Locomotive Works, and is to be used on a plantation in Santo Domingo. The gauge is 2 ft. 6 in., and although the locomotive weighs 60,200 lbs. total it will be operated over a track laid with 25 lb. rails, and having curves of 175 ft. radius. A tractive effort of 11,630 lbs. can be exerted, which, considering the track conditions, is very large.

The locomotive is, in general, a miniature of the engines built at these works for road service on the Great Northern Railway, illustrated in this journal June, 1907, page 213. The weight on drivers is 51,900 lbs., which gives an average weight per axle of 8,650 lbs. The front set of frames are connected by an articulated joint having the pins in the center of the high pressure saddle, which is cast separately from the cylinders. The frames throughout are of cast steel and are in one piece on each side of each group of wheels. The leading truck is center bearing and is equalized with the front group of drivers, while the trailing truck is side bearing and is equalized with the rear group. All four cylinders have slide valves operated by Walschaert valve gear. The reverse shaft for the high and low pressure gears are connected by a single reach rod, placed in the center line of the locomotive and passing through a slot in the high pressure cylinder saddle. It is provided with a knuckle joint immediately in front of the articulated frame connection. The reversing is effected by the usual lever and also by a hand wheel and screw, either of which may be used.

The boiler is of the straight top type, with a radially stayed fire box set on top of the frames. The grate is arranged for wood burning, as is also the front end and the stack. The boiler is fed by two injectors and has an auxiliary duplex feed pump located on the left hand running board, immediately in front of the cab. Steam brakes are used. The tender has a capacity of 1,200 gallons of water and 1½ cords of wood. The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Wood
Tractive effort	11,630 lbs.
Weight in working order	60,200 lbs.
Weight on drivers	51,900 lbs.
Weight on leading truck	4,550 lbs.
Weight on trailing truck	3,750 lbs.
Weight of engine and tender in working order	85,000 lbs.
Wheel base, driving	6 ft.
Wheel base, total	27 ft.
Wheel base, engine and tender	43 ft. 9½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.44
Total weight ÷ tractive effort	5.18
Tractive effort × diam. drivers ÷ heating surface	700.00
Total heating surface ÷ grate area	58.30
Firebox heating surface ÷ total heating surface, per cent	9.80
Weight on drivers ÷ total heating surface	94.00
Total weight ÷ total heating surface	110.00
Volume equiv. simple cylinders, cu. ft.	2.43
Total heating surface ÷ vol. cylinders	220.00
Grate area ÷ vol. cylinders	3.77

CYLINDERS.

Kind	Mallet Comp.
Diameter and stroke	10 & 15 x 16 in.
Kind of valves	Bal. Slide

WHEELS.

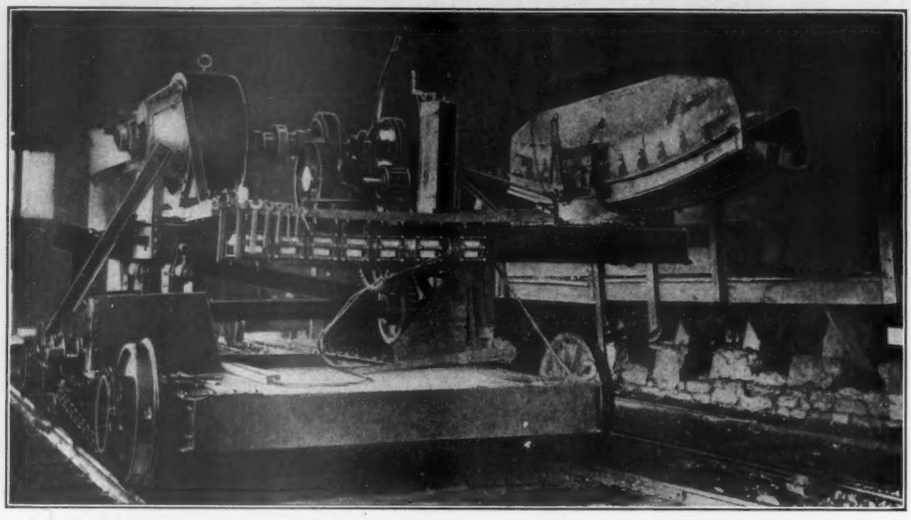
Driving, diameter over tires	33 in.
Driving, thickness of tires	2½ in.
Driving journals, diameter and length	4½ x 6 in.
Engine truck wheels, diameter	20 in.
Engine truck, journals	3½ x 6 in.
Trailing truck wheels, diameter	20 in.
Trailing truck journals	3½ x 6 in.

BOILER.

Style	Straight
Working pressure	180 lbs.
Outside diameter of first ring	36 in.
Firebox, length and width	67¼ x 20½ in.
Firebox plates, thickness	5/16, 3/8 & 7/16 in
Firebox, water space	F-3, S & B-2 in.
Tubes, number and outside diameter	88—1¾ in.
Tubes, length	12 ft. 6 in.
Heating surface, tubes	501 sq. ft.
Heating surface, firebox	49 sq. ft.
Heating surface, total	550 sq. ft.
Grate area	9 4 sq. ft.

TENDER.

Frame	6 in. chan.
Wheels, diameter	24 in.
Journals, diameter and length	2¾ x 5 in.
Water capacity	1200 gals.
Wood capacity	1½ cords



MACHINE FOR LOADING COAL INTO BOX CARS.

LOADING COAL IN BOX CARS.

It has long been known by coal dealers and others that much coal is stolen from shipments made in open cars, not alone when the cars are standing on sidings, but even when the cars are moving; sometimes by boys and men who steal a ride and throw off gunny sacks filled with coal, and even by the railroad employees themselves, who shovel off coal near their homes. Naturally the customer who receives the shipment is short by the amount of coal thus lost, for it is seldom that a man weighs his carload lots, and even if he does, he still has to pay for the amount shipped.

To overcome this, many customers have advocated that the coal be shipped in box cars, but in many cases the extra cost of the labor for loading and unloading was sufficient to prevent such shipments being made, except where there was no alternative. Mechanical loaders have been used to some extent to reduce the cost of handling, but in most cases they throw the coal to the ends of the cars, causing considerable breakage, especially in soft coal.

To overcome these difficulties a number of coal companies have installed the type of box car loader shown in the illustration which pushes the coal into place even to the ends of the cars, and hence avoid breakage. The example shown has recently been installed at the Silver Creek colliery of the Philadelphia & Reading Coal & Iron Company at New Philadelphia, Pa., and is the first installation of the kind in the anthracite region. This type of loader, however, is used quite generally in the bituminous region.

Coal is supplied by chutes from overhead bins to the hopper of the loader from which it is distributed alternately to the ends of the car, the hopper being entirely inside the car when at work. The hopper rocks up and down and at the same time moves back and forth from one end of the car to the other. As it passes the door in each trip it receives coal from the chute and carries it to the end of the car, here it is emptied by the movement of a scraper which moves through the hopper, pushing the coal ahead of it. The motion of the hopper is reversed by reversing the motor, but a mechanical reversing device is used on the scraper. All the movements of the scraper, of the hopper inside as well as out of the car, and of the entire loader from one car to another are obtained from a single motor, and are under the control of a single operator by means of various clutches and reversing gears, all conveniently arranged for rapid operation. The loader is also used for moving the cars, loaded or unloaded, as required, and for this purpose a hook is provided on the truck, into which a rope may be fastened.

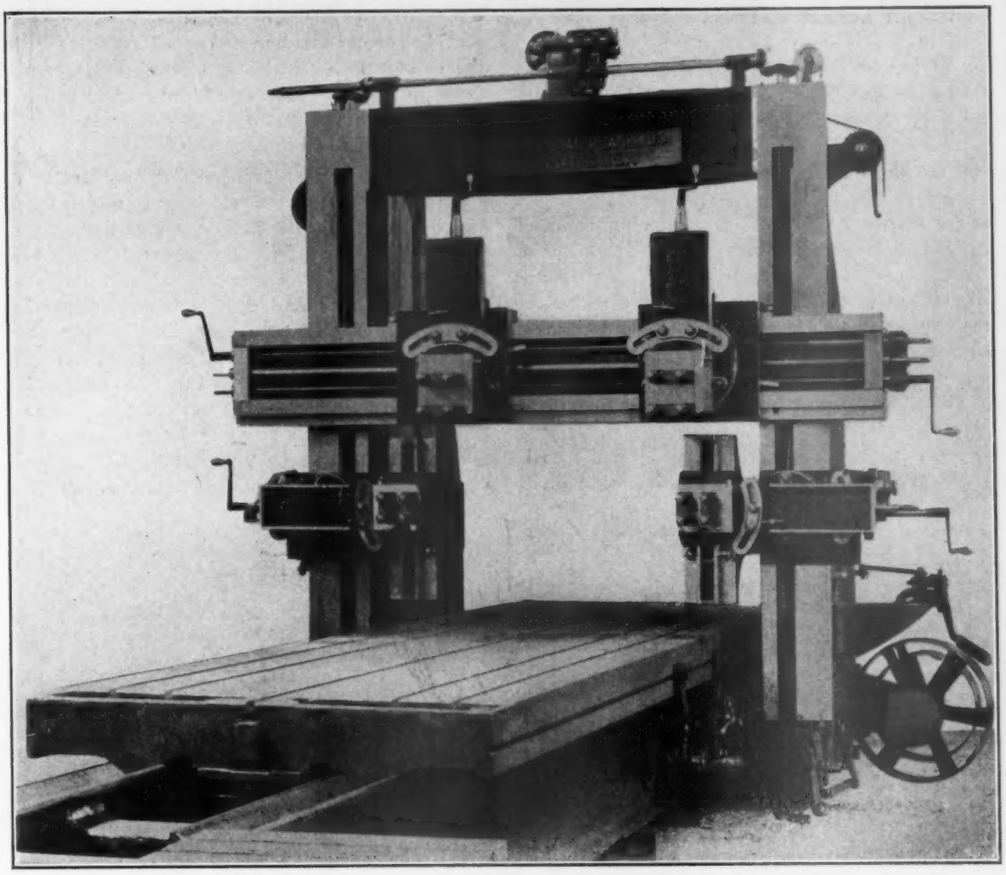
The motor is a Westinghouse direct current type "S" series wound design, running at 450 r. p. m. at full load. Power is supplied at 220 volts through two trolley wires (not shown in the illustration), as the track circuit is not used for return. The motor is controlled by a standard Westinghouse R-32 controller with grid resistance. It is necessary to reverse the motor at frequent intervals and to run at different speeds; hence the resistance has sufficient capacity to carry the current for an indefinite period. The motor has a rating of 75 h.p. on an intermittent service basis, which meets the requirements of this case, and is, in fact, capable of developing far greater torque.

This loader at the present time is used for loading chestnut, stove, egg and broken coals, and can handle all other sizes of anthracite coal with equal success. Thirty box cars are being loaded by this equipment in a nine-hour day, and sixty can be handled when conditions require it. The loader puts all but the last few tons into the car, and these are filled in directly from the chutes.

PNEUMATIC DESPATCH TUBE AT ENGINE HOUSES.

When the inspectors have completed their examination at the inspection pit each man writes his report on the proper form and sends it by pneumatic dispatch tube to the engine house office. By this means the reports covering the condition of the engine will reach the work distributor's desk almost as soon as the engine reaches the ash pit. The tube can easily be installed by any competent pipe fitter and is usually constructed of two-inch pipe laid in a box underground or carried on the ends of the ties. The fins should be smoothed off the inside of the pipe and a simple carrier can be made of an old air brake hose. When the reports are ready they are slipped into the carrier and the latter pushed into the open end of the tube. A hinged flap valve is then held against the tube and the air pressure turned on, a distance of several hundred feet requiring only a few seconds. As almost all of the larger engine houses are provided with air compressors, it is easy to secure the motive power needed by using a reducing valve set to a few pounds. The carriers as they come out of the tube strike against a spring buffer a foot or so away and drop into a basket. The man at the receiving end then signals to the other end by means of a bell or incandescent lamp and the air is shut off and the flap valve allowed to fall.

The usefulness and value of this simple and inexpensive tube system can hardly be appreciated by those who have never used it. The condition of an engine is known to the engine house force within a few minutes after it reaches the inspection pit, and they know at once whether the engine can be marked up for a run and a crew called or whether it will require shop attention which may take several hours. The condition of inspection pits and pneumatic tubes will save their cost many times over at nine-tenths of the large engine terminals of the country.—*Wm. Elmer, before the Railroad Club of Pittsburg.*



PLANER SPECIALLY ARRANGED FOR LOCOMOTIVE CYLINDERS.

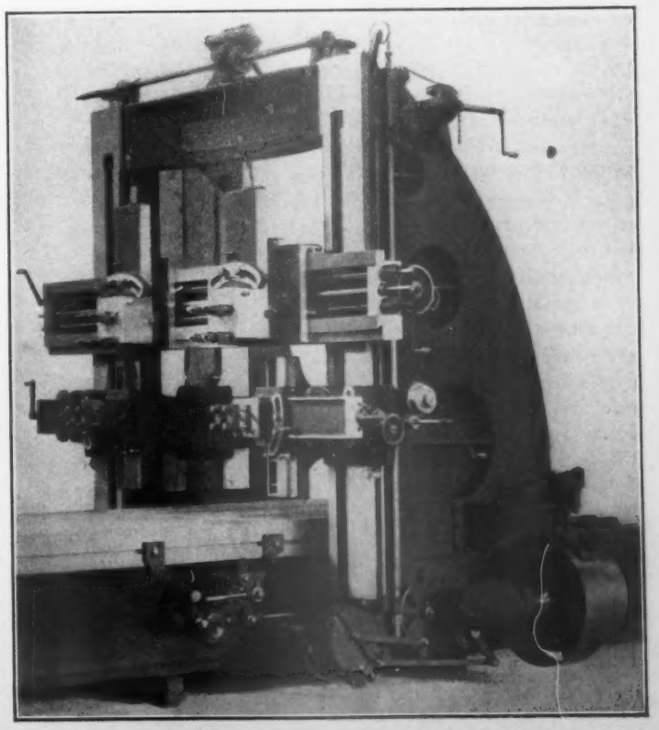
LOCOMOTIVE CYLINDER PLANER.

The accompanying illustrations give two views of a 72 x 72 in. x 18 ft. planer built especially for machining locomotive cylinders and particularly for cylinders with piston valves. The machine itself is a regular planer as manufactured by the Cincinnati Planer Co., and is arranged for a parallel drive. The changes making it particularly adapted for cylinders are in the arrangement of the side heads, which are a radical departure from the usual practice.

The planer housings are machined on the inside with a guide having a dovetail toward the front and a square face to the rear. A specially shaped bracket, counterweighted by a chain and weight (the latter not being shown in the illustration), fits in this guide and extends inward and forward toward the front of the housing. This bracket is secured to the housing at any point by tightening a taper gib on the straight side, which forces the bracket against the dovetail and draws it to a tight bearing. It is lifted up and down by means of a sprocket wheel, which carries the chain from the counterweight and is arranged with a crank for raising and lowering the bracket to suit the various cylinders. The front end of the bracket has a considerable height and is machined and scraped parallel to the front of the housing. This face carries a special shoe which has a dovetail on its forward side that fits the cross slide of the side head and is in line with it. This shoe slides up and down on the guide on the face of the bracket.

After the slide has been run on to the shoe the latter is adjusted to the bracket by means of two taper gibs and the shoe then becomes a part of the side head, so that when the latter is moved up or down it carries the shoe with it sliding on the face of the bracket. Thus when it becomes necessary to reach out, say twenty-four inches, from the housing edge, this bracket offers additional support to the side head and greatly diminishes the strain which usually takes place on work of this kind. The bracket is made of a length to clear the projection on all sizes and makes of cylinders and yet have sufficient bearing to give the greatest desirable vertical movement to the side head.

Whenever the machine is to be used for other purposes than cylinders the slide can be run back in the usual way on the side head and the bracket raised up out of the way, the machine then having the usual full capacity for ordinary planing. This machine is being manufactured by the Cincinnati Planer Co., Cincinnati, O.



EFFECT OF BRICK ARCHES AND BLOWERS ON SMOKE FROM LOCOMOTIVES.

The Department of Smoke Inspection of the City of Chicago recently made some quite extensive tests for obtaining accurate information on the possibilities of reducing the amount of smoke caused by locomotives within the city limits. A bulletin which has been issued by the department contains a complete account of the tests and a general discussion of the subject.

In considering the matter of blowers for forming artificial draft when the steam is shut off the bulletin states, "much smoke is caused in locomotive operation by inefficient blower arrangements, either in the cab or in the smoke box, or by carelessness on the part of the engine crew in not putting whatever blower arrangement their locomotive is equipped with into operation. The only function of the blower as a smoke preventative is to induce a draft to draw air into the fire box in order that there may be enough oxygen supplied, in the absence of a draft produced by exhaust from the nozzle, to completely burn the coal. The best blower arrangement, therefore, is the one that gives If it is arranged to be automatic it should open when the throttle is closed and remain open after the throttle has been opened, until the engine has required speed enough for the exhaust from the cylinders to furnish sufficient draft." An illustration and description of an automatic blower valve which operates in this manner and is being very successfully used by one of the railroads in Chicago is given.

The effect of brick arches on the amount of smoke given out by a locomotive in regular operation was most carefully studied and the writer of the bulletin states that all of the reports of tests with brick arches, as compared with no arch, have been most favorable to their use. "Whether their use is economical or not, provided their expense is not so great that it would be prohibitive, should not stand in the way of their adoption, for they are efficient as smoke preventors. Many tests have been made to determine the value of arches in the saving of fuel. Among these a series of very comprehensive tests has recently been made by the Lake Shore & Michigan Southern Railway. In this investigation a very careful record was kept of the fuel used, the miles run and the tonnage hauled,

COMPARATIVE BRICK-ARCH TEST

	No Arch	Arch	No Arch	Arch	No Arch	Arch	No Arch	Arch
Engine number	4676		4664		4668		4650	
Duration of test	10 da.	10 da.	10 da.	10 da.	10 da.	10 da.	10 da.	10 da.
Train numbers	10 & 5	10 & 5	28 & 23	28 & 23	37 & 4	37 & 4	50 & 3	50 & 3
Average number cars per trip	9.1	9.2	8.8	8.9	6.2	6.9	5.3	5.3
Average tonnage per trip	479.5	495.8	457.5	459.9	299.3	311.5	226.8	228.0
Total number of miles	2680	2680	2680	2680	2680	2680	2770	2770
Total number of ton miles	1,285,060	1,328,744	1,226,100	1,230,120	802,164	834,820	628,236	617,710
Total tons coal consumed	130.5	118.7	140.2	129.6	119.8	110.9	111.2	100.6
Lbs. coal consumed, 1000 ton mi	203	181	228	210	298	265	353	325
Cost coal consumed, 1000 ton mi.	$ 0.179	$ 0.159	$0.200	$0.184	$0.262	$0.232	$0.310	$0.286
Avefage steam pressure per sq. in.	196.6	198.3	190.3	196.6	194.1	196.5	195.5	197.2
Number of times flues cleaned	15	6	19.	9	17	12	16	10
Total cost of cleaning flues	0.43	0.21	$0.71	$0.31	$0.59	$0.18	$0.56	$0.21
Number of times netting cleaned	16	7	19	9	18	10	18	10
Total cost of cleaning netting	0.37	0.11	$0.58	$0.23	$0.46	$0.24	$0.40	$0.21
Material and labor cost cost, installing first arch	0.00	8.36	0.00	8.36	0.00	8.36	0.00	8.36
Cost of materials for replacing broken brick	0.00	0.00	0.00	0.70	0.00	1.44	0.00	0.71
Cost of labor for above replacement	0.00	0.00	0.00	0.08	0.00	0.12	0.00	0.06
Cost of material for replacement on acct. flue work	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cost of labor for above replacement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number of times brick cleaned off	0	0	0	0	0	0	0	0
Total cost of cleaning brick	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost for maintenance per 1000 miles	0.00	3.10	0.00	3.41	0.00	3.66	0.00	3.30
Gross amount saved by use of arch over no arch, 1000 mi.	0.00	7.99	0.00	7.16	0.00	8.20	0.00	5.88
Net amt. saved by use of arch over no arch, 1000 mi.	0.00	4.89	0.00	3.75	0.00	4.55	0.00	2.58

results approaching as nearly as possible the conditions which exist when the engine is working steam."

Tests were made on a number of different types of blowers by the department and it was found that a combination blower and exhaust tip, adaptable to locomotives having a single nozzle, gave the best results. This consists of a special exhaust tip having an annular chamber into which the blower steam pipe is led. Sixteen ¼ in. openings or jets from the chamber are arranged in a circle around the outside of the nozzle and so directed that the steam from them forms a single hollow jet, filling the stack near the top. The advantages claimed for this blower are that it induces sufficient draft, is economical in steam consumption and is comparatively noiseless.

On locomotives having a double exhaust tip this arrangement of blower is not practical and a double blowing arrangement, consisting of two pipes extending up from the nozzle on either side and ending at about the base of the stack, being inclined inward, so as to cause their combined jets to fill the stack near the top is advocated. The tips of these blowers are flattened down to give a wide thin jet of steam, the opening being but ¼ in. wide from a 1 in. pipe.

In discussing this subject the bulletin states that, "in order to obtain good results no blower connection should be less than 1 in. pipe and the blower itself should have an aggregate opening of the same size as the pipe. In order to facilitate the operation provision should be made for the engineer and firemen to open the blower independently of each other, or better, to make the means of opening the blower partially or wholly automatic.

together with all expenses incident to the arches. Four engines were used in the tests, each one running on the same train for ten days without the arch and ten days with the arch. The results given in the table above show a very gratifying saving of fuel, which amounts to approximately 9 per cent. The net saving in dollars and cents per thousand miles varies from $2.58 to $4.89, or an average of $3.44.

The department undertook, some time ago, an extensive series of observations to determine as nearly as possibly, the relative value of different arrangements of blowers and arches as smoke preventers. Through the courtesy of the Chicago, Burlington & Quincy R. R., the observations were made with locomotives on that road. These locomotives were in suburban service between Chicago and Downers Grove. The observations were made by A. J. Cota, master mechanic of the Chicago terminal division, simultaneously with, but independently of, G. E. Ryder, deputy smoke inspector of the city of Chicago, the results checking very closely.

The object of these observations was to obtain some definite data upon which could be based a comparison of various arch and blower arrangements. To make this comparison fair to each arrangement, care was taken to eliminate as much as possible any features that would give any one equipment an advantage over any other; and at the same time select power that would not class any part of the results as observations made under special conditions. Four locomotives were selected and the equipment changed from time to time as follows: Engine No. 110, no arch, with ¾-in. straight blower; engine No. 1143, no arch,

with 1-in. double blower; engine 1110, solid front arch, with ¾-in. straight blower; engine No. 1143, solid front arch, with 1-in. double blower; engine No. 1112, double solid arch, with ¾-in. straight blower; engine No. 1143, double solid arch, with 1-in. double blower; engine No. 1112, double hollow arch, with ¾-in. straight blower; engine 1175, double hollow arch, with 1-in. double blower; engine No. 1143, broken arch, with 1-in. double blower; engine No. 1143, broken arch, with 1-in. double blower.

By the straight blower is meant the ordinary blower pipe in the smoke box directed vertically toward the center of the stack, the form most commonly used in locomotives. The double blower consists of two pipes, one on each side of the exhaust nozzle. The tip of this blower is somewhat above the exhaust nozzle and is flattened to give an opening about ¼ in. in width.

The double solid arch arrangement is identical with the solid front arch except that a crown is added as shown in C on the chart. The double hollow arch is the same as the double solid arch, differing only to the extent that it is made hollow for the purpose of admitting air over the fire. Air is admitted through combustion tubes in the sides of the fire box, conveyed through the arches and delivered to the fire box from the nose of the front arch and the lower side of the crown arch. This arrangement is shown in D on the chart. The broken arches shown in E and F on the chart are made in the form of the solid front arch with the top brick placed in a horizontal position. The object of this arrangement is to change the direction of the gases, part of them passing through the opening in the arch and the remainder passing around the nose of the arch. This horizontal course of brick has somewhat the same action in the fire box of a locomotive that a mixing pier has in the combustion chamber of a stationary boiler setting.

Prof. Ringleman's method for classifying the smoke into six grades according to its density or percentage of blackness is the one most commonly used in observations of this kind. This method is explained as follows: In making observations of the smoke proceeding from a chimney, four cards ruled with different thicknesses of lines, together with a card printed in solid black and another left entirely white, are placed in a horizontal row and hung at a point about 50 feet from the observer and as nearly as convenient in line with the chimney. At this distance the lines become invisible, and the cards appear to be of different shades of gray, ranging from very light gray to almost black. The observer glances from the smoke coming from the chimney to the cards, which are numbered from 0 to 5, determines which card most nearly corresponds with the color of the smoke, and makes a record accordingly, at once noting the time.

The width of the lines and area of the spaces are so arranged that the black covers respectively 0 per cent., 20 per cent., 40 per cent., 60 per cent., 80 per cent. and 100 per cent. of the white surface of the card. This is graded for convenience into 0, 1, 2, 3, 4 and 5. By this means, for example, smoke proceeding from the stack which corresponds to card 3 is 60 per cent. black. Readings of the smoke on these observations were taken every fifteen seconds during the time of each run.

The results of these observations were plotted on charts for each run with each equipment. The chart, shown here, is the performance of each equipment on train No. 105. On the vertical scale the grade or per cent. black is plotted. The horizontal scale is the time. A second horizontal scale shows the number of shovels of coal at each firing and the time of the firing. The effect of heavy firing is evident from the smoke occurring after such a fire had been made.

CHART SHOWING THE EFFECT OF BRICK ARCHES ON SMOKE.

A NEW PIPE JOINT CEMENT.

It has been customary to furnish pipe joint cements and red or white lead for the same purpose already mixed with either water or oil, and no doubt a customer buying these cements pays as high a price per pound for the water or oil as for the cement itself. To obviate these disadvantages the H. W. Johns-Manville Company, New York, has recently placed on the market a pipe joint cement put up in powder form, which can, of course, be kept in stock indefinitely and does not dry up or deteriorate. It is simply necessary to mix this powder with water or linseed oil to make it ready for use.

The chemical properties of this cement are such that it expands after the joint is made up and does not harden like red or white lead, which permits the joint made with it to be easily broken at any time without danger of breaking the fittings. It is not poisonous and will not taint water. The manufacturers claim that one pound of this powdered cement, which has been given the name "H-O Pipe Joint Cement," is equal to four pounds of the usual ready mixed cement.

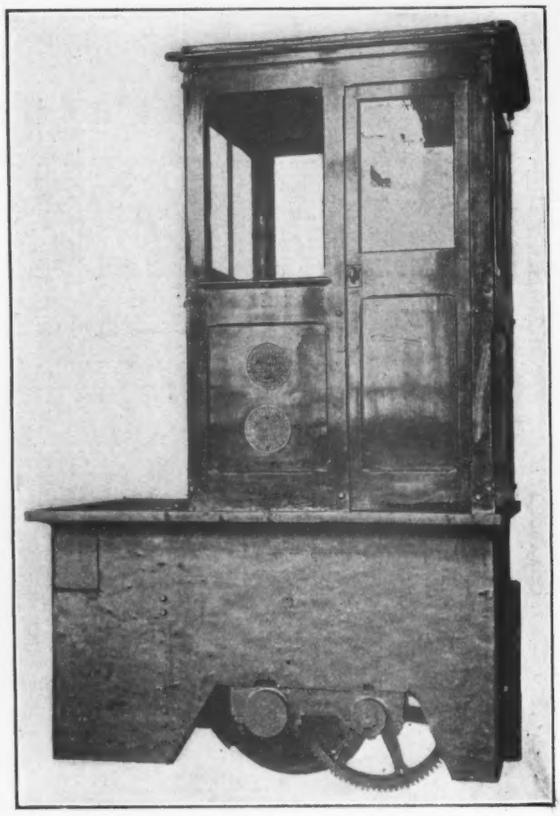
DIRECT CURRENT ON THE PENNSYLVANIA.—The Pennsylvania Railroad has adopted the direct-current system of electric traction, with third rail conductor, for its New York and Long Island tunnel extension. This decision was reached after making its own independent experiments, and is the result of mature consideration of the entire subject in view of the special requirements of its tunnels, station and yards. This system of electric traction is now in use on the lines of the Long Island Railroad, with which lines the tunnel extension will be directly connected.

ELECTRIC TURNTABLE DONKEY.

It has long been known that for doing work of a purely laborious sort, that is, requiring merely strength, the human animal is a very inefficient piece of apparatus when compared with a mechanical power producer such as an electric motor, inefficient both in point of size, weight and cost of operation. Nevertheless it has long been a very general custom to operate the turntables and often transfer tables on steam railroads by man power. A striking example of the economy and convenience which results from the use of electric power for this service is shown by the installation of a motor on a turntable on one of the railroads in New York state.

This turntable was formerly operated by hand, requiring the time of a number of men at intervals, which averaged the continuous service of two men for 24 hours a day. The donkey was equipped with a standard Westinghouse induction motor, known as type "F" high torque, rated at 20 h.p., 200 volts, two-phase, 60 cycles. This reduced the labor required to one man per day of 24 hours.

Inasmuch as the men were paid 15 cents an hour in each case this motor produced a saving of $3.60 a day, or $1,314.00 per

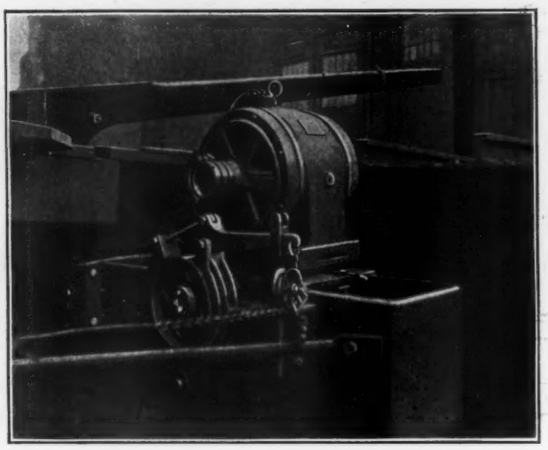


ELECTRIC TURNTABLE DONKEY WITH CAB.

year of 365 days. As the cost of power for the motor has averaged but $8.00 a month, or a total of $96.00 a year, the net saving is $1,218.00 a year. The total cost of the electrical equipment, including the cost of installing the outfit, was approximately $1,500.00, which is but slightly greater than the actual saving in one year.

The economy is not, however, the most important point in the advantages of the electrical equipment, although it makes a very good showing. The work of a turntable is intermittent and is usually rushing for a short time and then at a standstill, especially at terminals, where many locomotives often come in at the same time. The length of time required to turn a locomotive by hand depends largely upon the number of men available to do the turning, but even with the handles full, which condition requires from four to eight men, it is impossible to do the work as rapidly as with a motor. Hence the saving in time at such periods is of great importance as the congestion at the turntables is relieved and the movement of traffic is expedited.

The electric donkey forms a separate piece of apparatus consisting of a very heavy cast iron frame carrying a wheel which runs on the circular rail. The electric motor is mounted on this frame and drives the wheel through a reduction gearing of large ratio. The frame is securely connected and braced to the table in such a manner as to allow it to be free to move independently



ELECTRIC TURNTABLE DONKEY SHOWING MOTOR AND BRAKE.

in a vertical direction. A band brake is provided on an extension of the shaft of the driving wheel.

The method of supplying the electric power has some interesting details. A bridge is used with overhead wires, which run to an overhead collecting switch. This switch is constructed with brushes and collector rings so that contact is made at all times and in all positions of the turntable. It is so constructed that there is no strain on the line wires, as the cross arm to which they run does not move with the table, but is stationary while the table revolves.

In this installation the cab is mounted on the center of the turntable, so that the wires run directly from the bridge to the cab and then to the motor. In many instances the cab is mounted at one end, but instead of being directly on the table, it is mounted on the donkey directly over the motor, to overcome the jolting which the cabman would get when the locomotives run on and off. The type of cab which the Westinghouse Company has adopted as a standard for this work is shown in the accompanying illustration.

In many cases, especially in a new installation, the feed wires are run underground in conduit and brought up through the king pin in the center of the table. The same type of switch mentioned above is placed between the tracks and the connections made from this point in the usual manner.

"USE-EM-UP" DRILL SOCKET.

The advent of the expensive high speed drills has brought before all drill users more strongly than ever before the problem of the loss occasioned by twisted tangs and broken shanks. With the ordinary carbon steel drills, notwithstanding the fact that the loss was considerable from this source, it was generally neglected, and considered as an unavoidable evil. However, when

the tang was twisted off, or the shank broken on a high speed drill of approximately four times the value of an ordinary drill, and this expensive tool thereby rendered useless, the men in charge of such matters began to give the subject some serious thought.

A cure for this trouble has been devised by the American Specialty Company, Chicago, Ill., in the shape of a new type of drill socket, which is illustrated herewith. It will be noted that this socket is similar to the standard taper socket, with two exceptions. One, that it has a flat on its inside surface, and the other that the drift slot is somewhat longer than on the ordinary socket. to facilitate the driving out of tangless drills.

With this socket it is only necessary to grind a flat on the remaining portion of the shank after it has been broken off, or the tang twisted off, in order to put the drill into immediate use, or if a flat is ground on a new drill the liability of trouble from this source is entirely eliminated. Several of the standard drill makers are now furnishing their drills flatted to fit this socket at the same price as the ordinary drill.

It will be noted that flattening drill shank to fit this socket does not in any way interfere with its use in the standard taper socket.

A NEW HIGH DUTY DRILL.

A 24-inch drilling machine, especially adapted for handling high speed drills of from ½ to 1¾ in. in diameter, when drilling in solid steel to their full cutting capacity, has just been designed and is being manufactured by The Foote-Burt Company, Cleveland, O. In addition to the size shown in the illustration a smaller size of the same type is being manufactured and it is planned to build two larger sizes in the near future.

This machine contains a number of improvements and the design throughout is marked by extreme simplicity. It is single speed pulley driven, all speed changes being made by a quick change gear device located in the foot of the column. The levers for starting and stopping the machine and for changing speeds and feeds are conveniently located within easy reach of the operator.

All bearings are bronze bushed and are provided with liberal oil grooves. Throughout the machine spur gears are used, except one pair of slow running 2-to-1 bevel gears at the driving end, and one worm and worm gear for the feed. The spindle is of forged high carbon steel fitted with a ball thrust bearing.

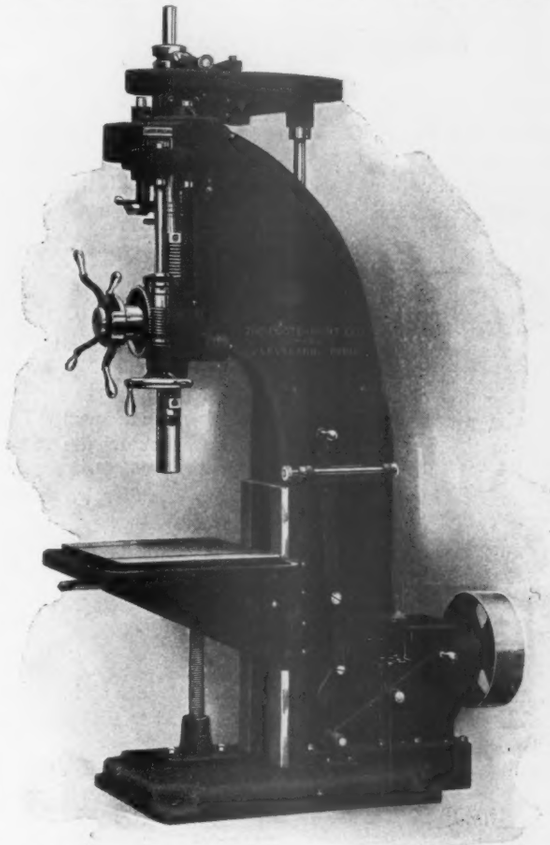
Three changes of geared feed are provided, any one of which is instantly available by shifting a lever at the front of the machine. All of the feed changes can be made without stopping the machine. The power feed is equipped with an adjustable automatic stop and a hand stop. The hand feed is through a worm and worm wheel, and quick traverse of the spindle in either direction is afforded through the spider hand wheel at the front of the machine which is engaged or disengaged automatically.

Nine spindle speeds are available through a double train of gearing, which is always in mesh and runs in a bath of oil. The device employs a lock bolt engaging any one of three gears, in each of the two trains, thereby giving the nine different speeds, any one of which is instantly available by shifting the levers at the side of the machine, directions for the use of which are given on the index furnished. At the end of the speed box is the pair of 2-to-1 bevel gears inside of the column, making the connection to the vertical driving shaft. Between the latter and the spindle gear is an idle spur gear, making it unnecessary to employ any more bevel gears.

When desired, a tapping attachment can be furnished which consists of a positive steel clutch, located on the idle gear on the top of the machine. It obviates the necessity of driving and leading the spindle through the keyed member of the clutch. The attachment reverses at a ratio of 2 to 1.

The table is of the bracket knee type and has a large square lock bearing surface on the upright, to which it is securely gibbed. It is further supported and elevated by a square thread jack screw beneath it, slightly back of the center of the spindle, to permit boring bars or other tools passing through the table. It is also provided with a liberal oil groove and T-slots.

This machine has the following dimensions: The distance from the center of the spindle to the face of the column is 12 inches. The maximum distance from the nose of the spindle to the top of the table is 28 inches; the length of power feed is 16 inches; the spindle has a diameter of 3 inches at the nose, and is provided with a No. 4 Morse taper. The spindle driving gear is 8⅞ inches in diameter with a 1½-inch face. The table has a vertical adjustment of 20 inches. The nine spindle speeds range



HIGH DUTY DRILLING MACHINE WITH SINGLE SPEED DRIVE PULLEY.

between 71 and 306 revolutions per minute. The three feeds are 0.007, 0.016 and 0.033 inch respectively. The net weight of the machine is 2,450 pounds.

As an extra attachment, a compound table can be furnished, with a knee specially built for supporting it. This compound table has a longitudinal adjustment of 14 inches, and a cross adjustment of 8 inches. The working surface is 16½ × 30 inches. When the compound table is furnished, the maximum distance from the nose of the spindle to the top of the table is decreased by 3¾ inches.

FRANK THOMSON SCHOLARSHIP EXAMINATION.—The General Managers of the Pennsylvania Lines East and West of Pittsburgh announce that the examinations of applicants for the Frank Thomson scholarships will be held in June, 1909. These scholarships, amounting to $600 a year, were established in 1907 by the three children of the late Frank Thomson. After 1910 there will be eight holders of scholarships, and this number is expected to be maintained in succeeding years. The examination will be open to the sons of all employees of the Pennsylvania and its controlled lines. The College Entrance Examination Board of New York City will conduct the examinations. Applications are to be sent before June 3 to Thomas S. Fiske, Secretary.

It is reported that the Pullman Co. is experimenting with a view to discover some material to replace the plush which covers the seats of its cars.

ECONOMY SOCKETS AND SLEEVES.

Every user of Taper Shank Drills has had a number of them made useless because of broken or distorted tangs, caused usually by worn or poorly fitting sockets. Such drills are in most cases consigned to the scrap pile which is necessarily a very expensive practice.

To meet the growing demand for a device to utilize such drills,

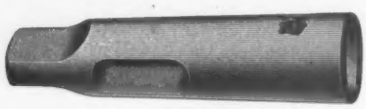


FIG. 1.

The Standard Tool Co., Cleveland, O., is making a special type of socket shown in Figs. 1 and 2. These are similar to the regular sockets and sleeves on the market, but with the slot for driving lower down and of larger dimensions.

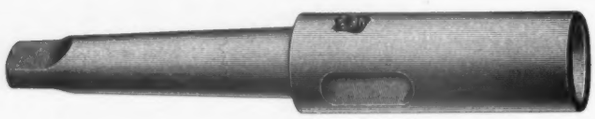


FIG. 2.

To provide a new tang to fit these sockets, the Economy Tang Gauge is used. By slipping it over the shank of the broken drill as shown in Fig. 3, a new tang can be marked of the correct size and position, which is then shaped either by milling,

FIG. 3.

planing, filing or grinding. The new tang is heavier and stronger than the old one, as will be seen in Fig. 4, and insures an accurate and powerful drive.

The shanks of the "Economy" sockets and sleeves are made to

FIG. 4.

standard dimensions and will fit the spindles of all the leading makes of power drill presses.

HIGH SPEED STEEL CUTTERS FOR SURFACING.

The advantages of high speed steel for cutting either metal or wood are generally appreciated, but its use, by simply replacing the present cutters with the new steel, is made impossible in a great majority of cases by the great expense and the difficulty in properly working and tempering it in such large sizes. The general, and most satisfactory, method of surmounting this difficulty is to use what amounts to a tool holder of proper design and first-class material, arranged to carry a comparatively small piece of high speed steel, which simply forms the cutting edge.

Among the most recent applications of this idea is the blade's cylinder for surfacing, beading and siding, shown in the accompanying illustration. This tool has been designed and is being manufactured by Samuel J. Sheimer & Sons, Milton, Pa. The new cylinder provides for the use of thin blades of high speed steel, which fit snugly in knife holders of high grade tool steel, which in turn fit in the grooves in the cylinder. The knife holders form part of the chip-breaker and when worn or injured may be replaced without discarding the cutter head. The high speed steel blades when properly tempered and treated will serve for one or two days' work on hard maple, oak or hickory.

This new type of cylinder has many advantages in point of simplicity and durability. The blades may be kept in good working order with less grinding and less trouble in setting and fastening to the head and are also less liable to get out of balance owing to their lighter weight. The chip breakers are easily renewed and the thin blades of the high speed steel being so carefully reinforced with the holding clamps are entirely free from the possibility of breakage.

WATER SOFTENING AND LEAKAGE OF FLUES.—Experience would indicate that the amount of hard scale present is a true index to flue leakage. In our Ohio district we encountered extremely hard water which resulted in overcrowding our shops with power on account of flue failures; but after the installation of water-softening plants at all of the important stations, a decided reduction was obtained, which at once improved the general efficiency of the power. There is hardly a question but that the presence, to an extent, of hydrates and carbonates in treated waters decreases the tendency towards corrosion, leaving to be controlled the amount of total solids and excess of reagents so as to prevent boiler foaming. The use of soda ash in waters containing free acid, or any dissolved salts, such as magnesium chloride, decreases corrosion, thereby increasing the life of the flue material.—*Alexander Kearney, assistant superintent motive power, Norfolk & Western Ry., before the Richmond Railroad Club.*

AUTOMATIC BLOCK SIGNALS IN 1908.—According to the *Railroad Age Gazette* over 900 miles of railway were equipped with automatic block signals during the year 1908 and it is probable that 2,000 miles will be equipped in 1909.

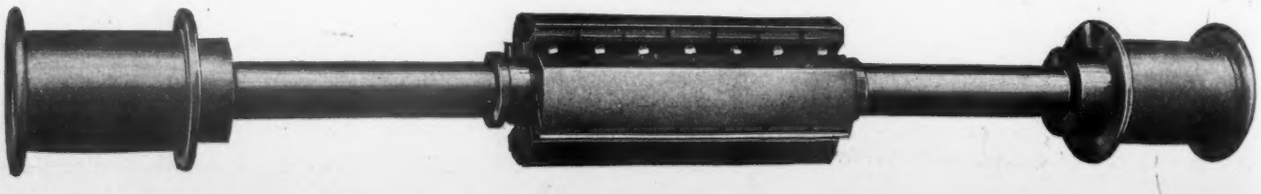
BOOKS.

Spring Tables. By Egbert R. Morrison. 6 x 9 in. 84 pages. Bound in cloth. Published by E. R. Morrison, Sharon, Pa. Price, $2.00.

This book, which is designed as a handbook for engineers, students and draftsmen, is practically entirely given up to tables giving data in connection with various types of springs. The formulae for springs of the usual types are given in the first few pages, following which are a number of very handy tables giving the fractional parts of π, and another of the 5th powers from 1-16 to 2, and a table giving the cubes from 1-16 to 3½, advancing by sixteenths. The most useful information in connection with helical springs takes up the next 52 pages, there being one table for light steel springs and tables for heavier springs with a diameter of bar varying from 1-16 to ½ in. by sixteenths. A section is then given to rectangular sections of helical springs and the remainder of the book is taken up by similar tables for elliptic springs.

Proceedings of the American Railway Master Mechanics' Association. Forty-first annual convention. Atlantic City, June 22 to 24, 1908. Published by the association. J. W. Taylor, Secretary, 390 Old Colony Building, Chicago.

The full report of the committees and the discussions thereon on the floor of the convention are given in this volume. Very



valuable reports were given at the 1908 convention by committees on the following subjects: Apprenticeship system; Blanks for reporting repairs on engines; Castle nuts; Four-cylinder compound locomotives; Mallet compounds; Mechanical stokers; Revision of standards; Safety valves; Superheating; Washing-out and re-filling boilers, and Widening the gauge of track on curves. In addition to the committee reports topical discussions were given on the following subjects: Alloy Steel; Standardization of Locomotive Parts; Smoke Nuisance; Ball Joint Unions for Steam and Air Line Connections and Non-combustible Engine House Jacks.

Proceedings of the International Railroad Master Blacksmiths' Association. Sixteenth annual convention. Cincinnati, August 18 to 20, 1908. Published by the association. A. L. Woodworth, Secretary, Lima, O.

The subject discussed at the last annual meeting of this association included committee reports on Tools and formers; Flue welding; Case hardening; Piece work; Locomotive frames; Thermit welding; Frogs and crossings; High speed steel and Manipulation of tool steel. This association now has a membership of 280 and will hold its next convention at Niagara Falls.

Tables of Quantities for Preliminary Estimates. By E. F. Haugh and F. D. Rice. 4½ x 7 in. 92 pages. Cloth. Published by J. Wiley & Sons, 43 E. 19th St., New York. Price, $1.25.

This book is practically entirely given up to tables of earthwork, which have been designed primarily for the requirements of the locating engineer, and are published in compact and convenient form for field use. The formulae and methods of calculation are given in the first few pages. A few other tables of interest and value to the locating engineer are included.

Proceedings of the Master Car Builders' Association. Forty-second annual convention. Atlantic City, June 17 to 19, 1908. Published by the association. J. W. Taylor, Secretary, 390 Old Colony Building, Chicago.

A large number of unusually important subjects were reported upon at the last convention by various committees, standing and temporary, and were given very energetic and interesting discussion. Among some of these reports might be mentioned the ones on the revision of the various rules of the association; Standards and recommended practice; Steel passenger cars; Ventilating and heating passenger cars; Cast iron wheels and Automatic connectors. Definite action was taken on a number of the most important recommendations and others will be brought up at the next convention for further discussion. The volume includes a full list of drawings, showing the standards and recommended practice of the association, as well as a list of members with their addresses, the constitution, etc.

Proceedings of the Traveling Engineers' Association. Sixteenth annual meeting. Detroit, Mich., August 25 to 28, 1908. Published by the association. W. O. Thompson, Secretary, Buffalo, N. Y.

The proceedings of this association continue to increase in size and value each year and the last one is filled with suggestions and reports on appliances for locomotives, all tending towards better locomotive service on American railways. The subjects considered by the association are, in general, those with which they are more familiar and better informed than any other railroad men and hence the ones on which the opinion of the members is of the greatest value. Among the subjects discussed are reports on The amount of territory a road foreman of engines should cover; Tests to locate defects of the new types of locomotive brakes and remedies for them; Service of superheaters on locomotives; Best method for training firemen in the proper methods of firing; Discussion on electric locomotives; How road foremen can best assist in increasing railway net earnings; Influence of education on engine men; Steam reversing gears; Size of air pump exhaust, etc. This association now has a total membership of 656. The proceedings include a list of all members with their post office addresses.

PERSONALS.

H. Carrick has been appointed assistant division master mechanic of the Oregon Short Line, with office at Pocatello, Idaho.

Frank Rusch has been appointed master mechanic of the Chicago, Milwaukee & St. Paul lines west of Butte, with office at Seattle, Wash.

James McBrian has been appointed district car inspector, Choctaw district, of the Chicago, Rock Island & Pacific Ry., with office at Argenta, Ark.

E. F. Jones, acting master mechanic of the Chicago & Western Indiana Ry., has been appointed master mechanic, with office at Chicago, succeeding P. H. Peck.

G. W. Rink, chief draughtsman of the Central Railroad of New Jersey, has been appointed mechanical engineer, with office at Elizabethport shop, succeeding Mr. Flory.

F. C. Fosdick, assistant master mechanic of the Chicago and Northwestern Ry. at Chicago, has been appointed master mechanic of the Iowa and Minnesota divisions at Mason City, Ia.

R. Emerson, assistant engineer of methods of the Santa Fe at Topeka, has resigned to become assistant to the general manager of the Lehigh Valley, with headquarters at So. Bethlehem, Pa.

William Hutchinson, master mechanic of the Iowa and Minnesota divisions of the Chicago and Northwestern Ry., at Mason City, Ia., has been appointed master mechanic of the Ashland division at Kaukauna, Wis.

S. C. Graham, master mechanic of the Ashland division of the Chicago and Northwestern Ry. at Kaukauna, Wis., has been appointed master mechanic of the lines west of the Missouri river at Missouri Valley, Ia.

E. W. Pratt, master mechanic of the Chicago and Northwestern Ry. lines, west of the Missouri river at Missouri Valley, Ia., has been appointed assistant superintendent of motive power and machinery, with office at Chicago.

E. A. Walton, division superintendent of motive power of the New York Central and Hudson River R. R. at Albany, has retired, and his duties have been assumed temporarily by Mr. Daniel R. MacBain, assistant superintendent of motive power at that place.

Edgar B. Thompson, assistant superintendent motive power and machinery of the Chicago & Northwestern Ry., has been appointed superintendent of motive power and machinery of the Chicago, St. Paul, Minneapolis & Omaha Ry., succeeding John J. Ellis, retired on account of having reached the age limit provided for in the pension system of the company.

D. Gallaudet, master mechanic of the Chicago division of the Baltimore & Ohio R. R., has been appointed master mechanic of the Grand Junction Terminal of the Denver & Rio Grande Ry., with jurisdiction over the second district, second division; also that portion of the second district of the third division between Grand Junction, Somerset and Montrose, with office at Grand Junction, Col.

The office of superintendent of motive power, second division, of the Atlantic Coast Line, has been moved from Savannah, Ga., to Waycross. N. E. Sprowl, master mechanic at Savannah, has been appointed shop superintendent at Waycross, and W. J. Pamplin has been appointed master mechanic of the Savannah and Waycross districts, with office at Waycross, and jurisdiction

over the forces at Savannah, Ga., Jesup, Brunswick, Thomasville, Albany and Waycross, including enginemen and firemen assigned to these districts.

J. F. Bowden, master mechanic of the Baltimore & Ohio R. R. at Parkersburg, W. Va., has been appointed master mechanic of the Chicago division, with office at Garrett, Ind., succeeding D. Gallaudet.

B. P. Flory, mechanical engineer of the Central of New Jersey, has been appointed superintendent of motive power of the New York, Ontario & Western Ry., succeeding G. W. West, deceased. Mr. Flory was born at Susquehanna, Pa., on November 9, 1873. He graduated from Cornell University in the class of 1895, and before beginning railway work was for about three years a draftsman for the Anaconda Copper Mining Co. His first railway position was that of inspector on the Lehigh Valley, which position he took in 1899. He was later made chief draftsman, and in November, 1902, was made mechanical engineer. In 1903 he was transferred to a special staff, doing work pertaining to the, at that time, new shops at Sayre, Pa. In March, 1904, he was appointed mechanical engineer of the Central of New Jersey, which position he held until his recent appointment. Mr. Flory has designed and invented a number of motive power and rolling stock improvements now in successful operation.

CATALOGS

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

CAR INTERCHANGE MANUAL.—The McConway & Torley Company, 48th Street and A. V. Ry., Pittsburgh, are issuing a car interchange manual which contains a complete epitome of all the decisions of the arbitration committee of the M. C. B. Association up to date. Supplements are issued from time to time to cover the latest cases.

PIPE AND BOILER INSULATION.—A new catalog being issued by the H. W. Johns-Manville Company, 100 William street, New York, is devoted to a thorough presentation of the problems of insulating all kinds of heated and cold surfaces, such as pipes, boilers, flues, ducts, etc. as well as insulation for refrigerating and cold storage work.

VENTILATING DINING CARS.—The General Railway Supply Company, 922 Marquette Building, Chicago, is issuing a leaflet discussing the proper ventilation of dining and private cars so as to overcome the serious objection of the kitchen odors permeating the other parts of the car. This problem has been solved by this company and the method is illustrated and described in this leaflet.

ELECTRICAL APPARATUS.—The General Electric Company is issuing a number of new bulletins, each being the usual complete and satisfactory description of some particular electrical appliance manufactured by it. Among these might be mentioned No. 3647 on the subject of Tungsten lamps for battery service. These lamps are specially suitable for train lighting. No. 4638 is a guide for the design of medium and small capacity central station switchboards. No. 4628 describes the company's new mercury arc rectifier, which will operate on any frequency from 60 to 140 and can be supplied for operating on frequencies from 25 to 60.

ANVILS AND VISES.—Fisher and Norris, Trenton, N. J., are issuing a small catalog largely given up to illustrating and describing anvils of various kinds. Many of these are for special purposes and arranged for handy and accurate work. Under each is included a table giving the general dimensions for various sizes, with the weight in pounds and in some cases the prices. The same catalog also contains an illustration and a brief description of the Fisher double screw parallel leg vise which has many advantages for heavy work. A circular is also being sent out by the same company showing the new Fisher-Brooks bench vise, which is made of the finest quality of cast iron with jaws of cast tool steel welded on by a patented process and properly tempered. This vise is made in various sizes, as shown by the list in the circular.

FINISHED LOCOMOTIVE PARTS.—A very attractive, standard size, catalog, is being issued by the Locomotive Finished Material Company, Atchison, Kans. This company is engaged in a new departure in the railroad field and are in a position to furnish finished locomotive castings of any size from a packing ring to a cylinder without delay and at a price which can compete with practically any existing railway shop. The catalog is largely given up to illustrations of the work turned out by this company and views of the shops and machinery owned by it. Parts which require fitting are left with sufficient material at that point to permit the proper adjustment being made. For instance, cylinders are finished complete except the saddle. Solid piston heads are left ¼ in. large in diameter and ⅛ in. small in rod fit. Shoes and wedges are finished except the box face, and so on for other locomotive parts. The catalog contains many convincing arguments on the advisability of procuring work in this manner instead of doing it in the regular locomotive shops.

NOTES.

ERRATA.—It was erroneously stated in the January issue of this journal that the Cleveland Twist Drill Company was located in Cincinnati, O., instead of Cleveland.

CHICAGO CAR HEATING COMPANY.—W. H. Hooper, formerly general agent of the Safety Car Heating and Lighting Company, has been appointed assistant to the president of the above company, with headquarters at the general office, Railway Exchange Building, Chicago.

MRS. FRANCES A. W. MCINTOSH, formerly advertising manager of the Buffalo Forge Company and associate companies, has resigned that position to open an office at 103 Anderson Place, Buffalo, N. Y., where her services in the preparation and printing of advertising literature can be secured.

DEARBORN DRUG AND CHEMICAL WORKS.—Edward C. Brown, manager of the Hawaiian office of the above company at 42 Queens street, Honolulu, is making an extensive oriental trip during which he will visit Japan, China, Australia, Philippine Islands, Java and other important islands in the Pacific Ocean.

NEW SHOPS.—Large shops are being erected by the Caroline, Clinchfield & Ohio Railroad at Johnson City, Tenn. These will be the principal shops of the road and are to be equipped with modern machinery capable of handling the largest motive power. This road has been making a number of improvements and building large extensions during the past year and is contemplating other large extensions.

TATE, JONES & COMPANY.—The large new works of the National Sanitary Mfg. Company, at Salem, O., have been equipped throughout with the "Kirkwood" system of fuel oil burning manufactured by the above company at Pittsburgh. This installation presented a number of unusual and difficult conditions for the burning of fuel oil and the satisfactory performance of the equipment has been very gratifying.

JOSEPH DIXON CRUCIBLE COMPANY.—The December, 1908, issue of "Graphite" completed the tenth annual volume of this very interesting publication, which first appeared as a small sheet of four pages and has continued to grow in size and interest up to the present twenty and more pages, standard size, publication, which is welcomed by 15,000 subscribers and friends. It was one of the pioneers of the high grade house organ idea, that has lately become so popular.

AMERICAN STEAM GAUGE & VALVE MFG. CO.—It is announced that John B. Guthrie is the sole representative of this company in the Pittsburgh district, having been appointed January 1, 1909. His offices are in the Columbia Bank Building, corner 4th avenue and Wood street, Pittsburgh. It is also announced that the southern branch of this company, which for several years has been located in the Equitable Building, Atlanta, Ga., has been removed to No. 524 Candler Building, in that city.

AMERICAN BRAKE SHOE & FOUNDRY COMPANY.—Chas. R. Herron of Chattanooga, Tenn., late southern sales manager of the above company, died at his home on December 6, 1908. Mr. Herron was a highly respected citizen and well known business man of Chattanooga, with a host of friends throughout the south. He was born in Ireland in 1844 and came to America with his parents in 1848. His connection with the brake shoe business began in 1899, when he took charge of the Ross Mehan foundry at Chattanooga. He later became connected with the American Brake Shoe Company and in 1902 with the American Brake Shoe & Foundry Company, where he continued as southern sales manager until the time of his death.

AMERICAN LOCOMOTIVE COMPANY.—This company has purchased a plot of 130 acres of land at Gary, Indiana, from the Gary Land Company, a subsidiary company of the United States Steel Corporation, and plans are being drawn for a new plant which it is said will be the most complete and best equipped locomotive works in the world. The land purchased is twice the extent of that occupied by the largest of its present plants and when fully occupied will give employment to from 12,000 to 15,000 workmen. The land adjoins that of the new plant of the United States Steel Corporation. This site was selected at Gary, 24 miles from Chicago, to provide for the territory where the largest number of railroads converge to a single commercial center. The Chicago district is a great railroad center and that district is rapidly developing in manufacturing importance, which renders it favorable as a location for securing material for building locomotives. This company now operates plants in Schenectady and Dunkirk, New York; Pittsburgh and Scranton, Pennsylvania; Richmond, Virginia; Paterson, New Jersey; Manchester, New Hampshire; and Montreal, Canada. At present there is no large locomotive plant west of Pittsburgh, and the selection of a location in the Chicago district provides additional locomotive building capacity where it is most needed for prompt and direct delivery to a large number of railroads. The size of the new plant will be sufficient to provide liberally for the growing needs of the railroads for years to come.

MAINTENANCE AND REPAIR OF FREIGHT CARS.

With Special Reference to Steel Equipment.

PENNSYLVANIA RAILROAD AT ALTOONA.

INTRODUCTORY.

During the past few years there have been many inquiries from railroad officials concerning the advisability of introducing steel underframe or all-steel freight equipment on their lines. As the price of lumber has advanced the difference between the first cost of the wooden and the steel car of the same type and capacity has steadily decreased. The weight of the all-steel equipment for the same capacity is less; its life is considerably greater and as far as the body of the car is concerned the cost of maintenance is very much less. To demonstrate how simple it is to maintain and repair steel freight cars an extensive study of the methods in use on the Baltimore & Ohio Railroad at Mt. Clair was presented in the May, 1907, issue of this journal, and of the McKees Rocks plant of the Pittsburgh & Lake Erie Railroad in the January, 1908, issue.

The Pennsylvania Railroad adopted modern all-steel freight cars somewhat earlier than the Baltimore & Ohio. The methods of repairing and maintaining these cars were considered on the latter road first, because it was doing the work with very few special facilities, thus making it possible to demonstrate to the officers, having the adoption of steel equipment under consideration, that the work could be done successfully with very little special equipment. As a matter of fact, although the Pennsylvania Railroad has a shop at Altoona for making the heavier repairs to steel cars, which is very convenient and greatly facilitates the repairing of these cars, yet a large proportion of the heavy repairs are being made successfully in the repair yards under conditions which are no more favorable than those on the Baltimore & Ohio at Mt. Clair. At the present time only a small part of the steel shop is being used for repairs, the greater portion of it being devoted to the building of underframes for new freight and passenger equipment. The number of steel cars repaired in the shop per month fluctuates, depending upon the new equipment which is under construction.

Freight cars are repaired at four different places in Altoona; *i.e.*, at the east and west bound repair yards, the steel shop and the freight shop. While the heavier and the greater part of the repairs to the steel cars are made at the west bound repair yard and in the steel shop, light repairs are also made to these cars at the east bound repair yard and in the freight shop.

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THE ALTOONA YARDS.

To understand more clearly the relation of these four repair points to each other, it may be well to briefly study the general arrangement of the Altoona yards and the car shops, general plans of which are shown in Figs. 1 and 2. The Altoona yards consist of thirteen yards having 206.82 miles of track with 1,075 switches and a capacity for 10,500 cars. There are four humps, two on the west bound and two on the east bound tracks. As many as 169 trains, having 9,027 cars have been passed through the Altoona yards in one day.

The prevailing direction of heavy traffic is eastward, a large percentage of the west bound trains being made up of empties. West-bound freight trains enter the west-bound empty receiving yard, the loaded trains passing along the track at the north side of this yard and into the west-bound loaded receiving yard. After entering the receiving yard the locomotives and cabin cars are cut off and the cars are carefully examined by the inspectors. The hump between the receiving and classification yards for empty trains is ordinarily in operation about sixteen hours out of every twenty-four, and as many as 1,773 cars, requiring 654 cuts, have been passed over it from 6 A. M. to 6 P. M.

The operation of these yards has been improved and the number of damaged cars reduced by placing a searchlight at the hump, with a lens specially ground to include an angle to cover the extreme ladders at the head of the yard. The cars requiring repairs are shifted to special tracks in the classification yard, from which they are removed to the west-bound repair yard. After the west-bound trains are made up they are pulled to the west-bound advance tracks, where locomotives from the East Altoona roundhouse are attached and the air brakes are tested.

The cars in the loaded receiving yard, after they have been inspected, are shifted over a hump into the loaded classification yard. Cars requiring repairs are placed on a special track, from which they are taken to the west bound repair yard. The loaded trains, after they are made up, are taken to the west bound advance tracks, where the road engine is attached and brakes tested.

The east bound freight trains are handled in a similar manner. Certain tracks in the receiving yard are reserved for trains which are to be weighed, while others are used for trains

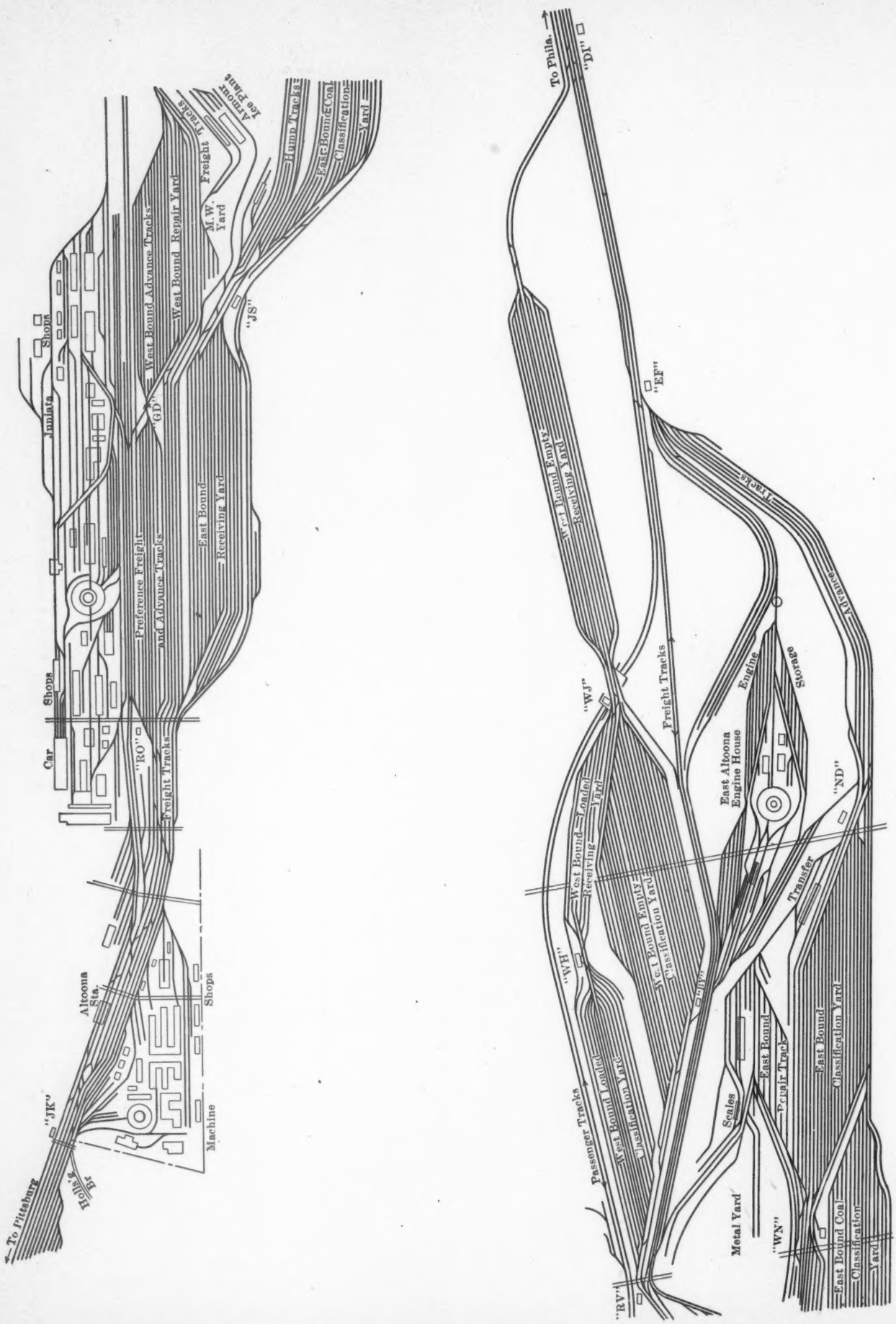


FIG. 1.—THE ALTOONA YARDS OF THE PENNSYLVANIA RAILROAD.

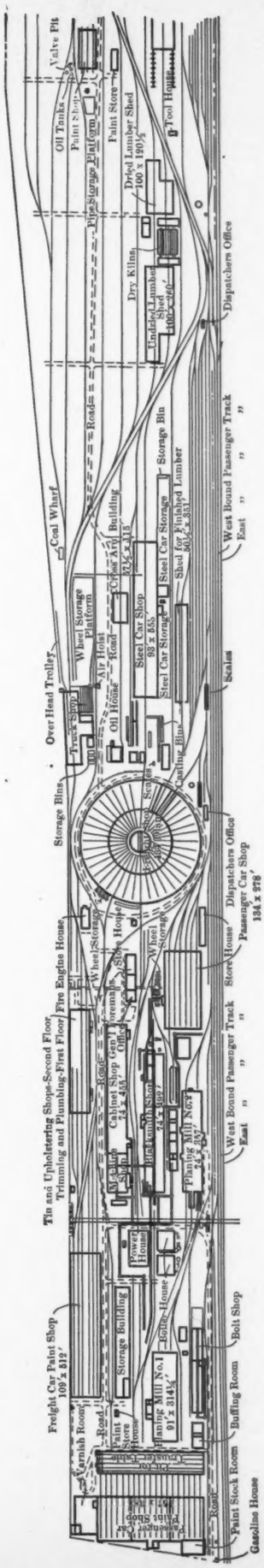


FIG. 2.—PLAN OF THE ALTOONA CAR SHOPS, PENNSYLVANIA RAILROAD.

that it is not necessary to weigh. The trains to be weighed are passed over a hump, and the scales, into what is designated as the east bound coal classification yard. The trains that it is not necessary to weigh are passed over a hump into the east bound classification yard. From the classification yards the cars are taken to the advance tracks and forwarded in the same way as the west bound trains. Cars requiring repairs are shifted to special tracks in the classification yards and are taken to the east bound repair yard.

Preference trains use the main freight tracks and are inspected and forwarded as quickly as possible. Cars in these trains requiring repairs are either shifted to a special track in the repair yard or are taken to the freight shop. The wrecking gang has its headquarters at the freight shop and takes care of the repairs of cars in preference trains which are received during the night.

As practically all of the cars going east are loaded, the east-bound repair tracks are specially equipped for handling loaded cars or transferring the loads. Ordinarily only slight repairs are made to the bodies of steel freight cars at this yard. If a car is received which requires heavy repairs the load is usually transferred and the car is forwarded to the steel car shop.

The heavier repairs to steel cars are supposed to be made in the steel shop, but at the present time it is being used largely for the building of new equipment. A large number of steel cars, many of them requiring comparatively heavy repairs, are being handled on the west-bound repair tracks. This work is done there very successfully, although, as will be shown, very little special equipment is used and conditions generally are not very favorable, since the yard is being used temporarily for this work and was not designed for repair yard purposes. Eventually the west-bound repair yard may be transferred to the space east of the Altoona roundhouse, between the main tracks and the advance tracks for the east-bound freight trains.

The freight shop is built in the form of a roundhouse, with a turntable at the center, and because of the difficulty in shifting cars in and out is used mostly for the heavier repairs to wooden cars and for repairing cars from the preference trains received during the night. Repairs to the trucks of steel cars may be made on any of the tracks in this house, but repairs to the body, or repairs requiring the driving of rivets, can be made on only a few of the tracks, alongside of which rivet heating furnaces have been placed.

PENNSYLVANIA RAILROAD STEEL FREIGHT CAR EQUIPMENT.

The first steel cars built by the Pennsylvania Railroad were the special flat cars constructed in 1887 for carrying wire cables for cable railroads. These are known as the Fd class and were designed to carry a concentrated load of 120,000 lbs. The Fe cars, built in 1889, were similar except that the capacity was 20,000 lbs. less. The Fg cars were built in 1892 and were designed for transporting heavy guns. One of these cars has a capacity for carrying 140,000 lbs. and consists of two small four-wheel cars with a bridge. The other has a capacity for 285,000 lbs. and consists of four small four-wheel cars with three bridges (AMERICAN ENGINEER, May, 1893, page 218).

In 1896 the Pennsylvania designed the Gm steel gondola cars (AMERICAN ENGINEER, October, 1903, page 352). Five of these cars were built by the Schoen Pressed Steel Company and delivered in June, 1898. As it is necessary to shovel part of the load through the drop doors these cars have not been very popular, although from the standpoint of maintenance they have given splendid results. No side sills were used, the sides acting as trusses to assist in carrying the load.

In July, 1898, the first Gl steel hopper cars went into service. This design was the result of conferences between the mechanical officials of the Pennsylvania Railroad, the Pennsylvania Lines West and the Schoen Company. The details of the car were largely developed by the Schoen Pressed Steel Company and were mostly of pressed steel. A large number of these cars were built during the following four or five years and were carefully watched and studied by the railroad officials. Based

ALL-STEEL FREIGHT CARS—PENNSYLVANIA RAILROAD

DECEMBER 31, 1908

Kind.	Class.	Capacity	Year Built													Total	No Cars Destroyed Since Placed in Service	Described in "American Engineer"
			1887	1889	1892	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908		
Flat Cars, Special.	Fd	120,000	1														1		
	Fe	100,000		1													1		
	Fg[1]	140,000			1												1		
	Fg[2]	285,000			1												1		May, 1893, p. 218.
	Fn	120,000 to 175,000						2									2		June, 1904, p. 209.
Flat Cars.	Fl	80,000							498								498		Oct., 1903, p. 354.
	Fm	100,000								38	769	71			7		885	2	Dec. 1905, p. 436.
Hopper Cars.	Gl	100,000				819	441	532	2831	4437	2711						11,771	5	Oct. '03, p. 352; Dec., '03, p. 435.
	Gl	110,000				251	104	118	392	537	437						1,839		
	Gla	100,000											1498	778	6077	235	8,588		
	Gla	110,000											2		1		3	1	May, 1905, p. 148.
	Gm	100,000				5											5		Oct. '03, p. 352; Nov. '03, p. 402.
Long Gondola.	Gsa	100,000								480	486	497	137	60			1,660		
	Gs d												270	15199	1450		16,919	2	Jan., 1906, p. 11.
Coke Gondola.	Gp																		Oct., 1905, p. 359.
	Gpa	100,000											200				200		Oct., 1905, p. 359.
	Gsa	100,000								13	46	39	3003				3,101		
	Gsd												30	1270	1000		2,300		Jan., 1906, p. 11.
Total ...			1	1	2	1075	545	650	3723	5505	4449	607	5140	17307	8535	235	47,775	10	

Fd and Fe were specially designed for carrying wire cables.

Fg[1] and Fg[2] were designed for carrying large guns, Fg[1] has two small four-wheel cars connected with a bridge, and Fg[2] has four small four-wheel cars, connected with three bridges.

Fn is a special car with a well-hole.

The main difference between the Gl cars of 100,000 lbs. capacity and those of 110,000 lbs. capacity is that the former have cast iron wheels and the latter rolled steel wheels. This is also true of the Gla cars.

GENERAL DIMENSIONS OF ALL-STEEL FREIGHT CARS—PENNSYLVANIA RAILROAD.

Class	Fd	Fe	Fg[1]	Fg[2]	Fn	Fl	Fm	Gl	Gla	Gm	Gsa	Gsd	Gp	Gpa
					120,000									
Capacity	120,000	100 000	140 000	285,000	175,000	80,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Weight	51,800	51,000	72,900	175,000	43,300	31,500	39,000	39,200	39,050	33,800	40,200	40,000	52,950	50,355
Face to face of coupler	42′ 2″	42′ 2″	57′ 10″	89′ 4″	39′ 11″	41′ 11½″	41′ 11″	34′ 11½″	34′ 2″	32′ 2″	41′ 11″	41′ 11″	43′ 11″	43′ 11″
Extreme Width	7′ 11″	7′ 11″	8′ 3½″	9′ 10″	10′ 0″	9′ 11½″	9′ 11½″	10′ 1⅜″	10′ 1⅜″	10′ 1″	9′ 11½″	9′ 11½″	10′ 0″	10′ 0″
Height from rail to top of sides	Flat	Flat	Flat	Flat	Flat	Flat	Flat	10′ 0″	10′ 0″	7′ 2″	7′ 2″	7′ 2″	12′ 0″	12′ 5″
Length inside body	"	"	"	"	"	"	"	31′ 6½″	30′ 5″	28′ 6″	38′ 2½″	37′ 2½″	40′ 2⅝″	40′ 2⅝″
Width inside body	"	"	"	"	"	"	"	9′ 6″	9′ 6″	9′ 5½″	9′ 3½″	9′ 3½″	9′ 4⅝″	9′ 4⅝″
Length outside body	39′ 2″	39′ 2″	55′ 7″	87′ 7″	38′ 0″	40′ 0″	40′ 0″	32′ 1″	31′ 0½″	29′ 0″	38′ 3″	38′ 3″	40′ 0⅝″	40′ 0⅝″
Width outside body	7′ 11″	7′ 11″	7′ 6″	9′ 10′	10′ 0″	9′ 3″	9′ 0″	10′ 1½″	10′ 1⅜″	10′ 8″	9′ 4″	9′ 4″	10′ 0″	10′ 0″
Height of sides above floor	Flat	Flat	Flat	Flat	Flat	Flat	Flat	6′ 6″		6′ 2½″	3′ 9″	3′ 9″		
Total wheel base	35′ 0″	35′ 0″	48′ 3″	80′ 3″	33′ 6″	34′ 6″	35′ 6″	28′ 9″	27′ 9″	25′ 7″	35′ 6″	35′ 6″	37′ 6″	37′ 6″

FREIGHT CARS WITH STEEL UNDERFRAMES—PENNSYLVANIA RAILROAD

DECEMBER 31, 1908

Kind.	Class	Capacity	Year Built								Total	Number Cars Destroyed Since Being Placed in Service	Described in the "American Engineer"
			1901	1902	1903	1904	1905	1906	1907	1908			
Box	Xl	100,000	986	3,172	1,529	891	701	5,308	3.652	3,441	19,680	51	Oct. '03, page 354. Jan. '04, page 3.
	Xla	100,000		748							748	2	
	Xlb	100,000					10				10		
	Xlc	100,000						100			100		
	Xm	100,000				4	3	5	4		16		
Long Gondola	Gr	100,000		6,315	4,093	227	3,149	134			13,918	2	Dec. '05, page 436.
	Gra	100,000								1,000	1,000		
Tank	Ad												
Stock	Kf	100.000				44	94		14		152		
Refrigerator	Rf	100.000		1		542	781	1,155	169	27	2,675	6	Jan. '04, page 3.
Cabin	Nd				1	29	219	281	279	59	868	5	June, '04, page 210.
Total			986	10,236	5,623	1,737	4,957	6,983	4,118	4,527	39,167	66	

Note—Gra is 40 feet long inside, holding two lengths of 20-foot tube. It was specially designed for this purpose.

GENERAL DIMENSIONS OF STEEL UNDERFRAME FREIGHT CARS—PENNSYLVANIA RAILROAD.

Class	Xl	Xla	Xm*	Gr	Gra	Ad	Kf	Rf	Nd
Capacity	100,000	100,000	100,000	100,000	100,000	12,000 gal.	100,000	90,000	28,000
Weight	45,300	44,200	53,200	44,000		41,000	47,100	56,900	27′ 10½″
Face to face of coupler	40′ 5″	40′ 5″	40′ 5″	41′ 11″	44′ 11″	38′ 11″	40′ 5″	40′ 5″	10′ 5⅞″
Extreme width	9′ 10″	9′ 10″	9′ 10″	9′ 11⅞″	9′ 11⅞″	10′ 0″	10′ 0⅜″		
Height from rail to top of sides				6′ 4⅜″	6′ 4⅜″				
Length inside body	36′ 0″	36′ 0″	32′ 5½″	37′ 8½″	40′ 8″	33′ 5½″	35′ 11½″	30′ 0½″	20′ 4½″
Width inside body	8′ 6″	8′ 6″	8′ 6″	8′ 9″	8′ 9″	7′ 11⅝″††	8′ 5½″	8′ 4″	8′ 2½″
Length outside body	37′ 1⅝″	37′ 1½″	37′ 1½″	38′ 3″	41′ 3″	37′ 0″	36′ 11⅞″	37′ 1½″	21′ 0″
Width outside body	9′ 4½″	9′ 4½″	9′ 4½″	9′ 4″	9′ 4″	10′ 0″	9′ 4½″	9′ 4½″	9′ 1⅜″
Height of sides above floor	8′ 0″†	8′ 0″†	7′ 6½†	2′ 6″	2′ 6″		8′ 0½″†	7′ 6″†	
Total wheel base	34′ 0″	34′ 0″	34′ 0″	35′ 6″	38′ 6″	32′ 6″	34′ 0″	34′ 0″	13′ 6″

* Produce. † Height inside. †† Diameter of tank.

(*See page 85 for Freight Car Classification.*)

FIG. 3.—OLD WOODEN FREIGHT CARS BEING DISMANTLED AT THE METAL YARD PREPARATORY TO BEING BURNED.

upon the experience thus gained the Gla and the other types of all-steel and steel underframe cars were designed.

The weakest point on the Gl cars proved to be the center sills, which were of pressed steel, 10 in. deep at the bolster. The cross-sectional area through the center sills at that point is only 12¾ sq. in. On the Gla and other types of cars which followed the cross-section was never allowed to be under 23 sq. in., and in most cases is considerably higher. The center sills on the Gl cars give considerable trouble directly back of the bolster. The rear draft lugs of the Westinghouse friction draft gear practically reach to the bolster and there is thus no opportunity for the sill to buckle in front of it.

The Gla cars (AMERICAN ENGINEER, May, 1905, page 148) are built principally of structural steel, the center sills being 10 in. channels, in place of the fish-bellied pressed steel sills used on the Gl. The center sills are reinforced by cover plates and also by angles at the lower flanges between the bolsters. There are no side sills between the bolsters, the sides being utilized to assist in carrying the load, as on the Gm cars. The Gla cars, although much stronger than the Gl class, weigh less. The increased strength lies mainly in the increased sectional area of center sill. They are seldom to be found upon the repair tracks for heavy repairs, but when this occurs, they are not so easily repaired as if of pressed shapes since the latter are more easily restored to their former shape while the structural shapes are inclined to break.

FREIGHT CAR CLASSIFICATION.

Each class of car is designated by a primary letter and the different styles of each class are designated by affixing to the primary letters other letters in alphabetical order. The primary letters used to designate freight cars are as follows:

A—Tank
F—Flat
G—Gondola
K—Stock
N—Cabin
R—Refrigerator
X—Box

The center sills are reinforced by diagonal braces extending from the end sill, near the center, to the side sills at the bolster (AMERICAN ENGINEER, May, 1905, page 148). It is customary on some roads to have this brace extend from the corner of the car to the center sill at the bolster, but since it is a comparatively simple matter to repair the corner it is believed to be better practice to place it so that it will reinforce the center sills.

It is practically impossible to design a steel car which cannot be damaged by rough handling and it would not be economy to do so if it was possible. Heavier power and the introduction of hump yards have greatly increased the severity of the service to which freight cars are subjected. Trainmen should be made to realize that the careful handling of equipment is an important factor in keeping down the cost of repairs. Poorly designed car unloading machines and careless handling of cars upon them is responsible for much damage. It would be folly for the designer to attempt to design cars to stand all the abuse which they might receive from these causes. The best interests of the railroad will be conserved by the removal of such abuses rather than by trying to build a car which will stand them. The later Pennsylvania cars are designed to stand end shocks of 300,000 lbs. every day, and occasional end shocks of 500,000 lbs. Thus far no serious defects have developed in any of the steel cars other than the Gl hopper cars.

A detail description of the design of the different types and classes of steel cars will be found in connection with a series of articles on "Steel Car Development on the Pennsylvania Railroad,"[1] which appeared in the AMERICAN ENGINEER during 1903, '04, '05 and '06. Particular reference to these articles will be found in the accompanying tables, which show the number of cars of each type of both all-steel and steel underframe cars in service on the Pennsylvania Railroad at the beginning of this year; also the year they were placed in service and the total number of each class which have been destroyed.

The Pennsylvania Railroad has 157,823 freight cars, of which 47,775 are of all-steel construction; 39,167 are wooden cars with steel underframes and the remainder are of wood. Thus 30.3 per cent. of the equipment is of all-steel construction and 24.8 per cent. has steel underframes. General dimensions and data for these cars[2] will be found on page 84.

THE PASSING OF THE WOODEN CAR.

The high capacity steel car has proved to be much more economical than the lower capacity wooden car. The steel cars are much stronger and may be handled more roughly without injury. The lower capacity wooden cars are not only more liable to injury when mixed in a train with steel cars, but they increase the chance of damage to the steel equipment. For these reasons the Pennsylvania Railroad decided a few years ago to destroy 12,000 wooden cars which, although in good condition, were of low capacity.

In addition the larger capacity wooden cars which require re-

[1] A study of the development in the design of steel cars on the Baltimore & Ohio Railroad will be found in the May, 1907, issue, page 163. Some suggestions as to improvements in the construction of steel cars will be found on page 402 of the October, 1908, issue. These were made by G. E. Carson in a paper read before the Railway Club of Pittsburgh.

[2] Similar data for steel cars on the Baltimore & Ohio will be found on page 161 of the May, 1907, issue.

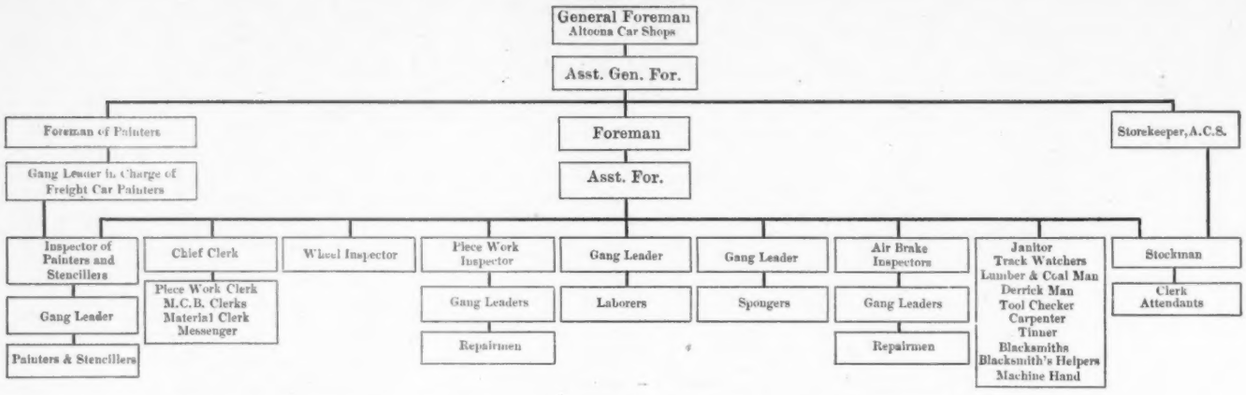


FIG. 5.—DIAGRAM SHOWING THE ORGANIZATION OF THE WEST-BOUND FREIGHT CAR REPAIR YARD.

pairs are looked over very carefully, and if the estimated repairs are considered too high they are destroyed. During the past three years over 18,000 of the wooden cars have been removed from service and destroyed. At Altoona such cars are taken to the metal yard and the air brakes, draft rigging, trucks and metal roofing are removed. If any of the longitudinal sills are in first-class condition they are removed and the remaining portion of the car is then burned, the metal scrap being gathered afterward. One of the illustrations, Fig. 3, shows a number of these cars which have been or are being stripped and are to be burned during the night.

THE LIFE OF STEEL CARS.[3]

It is practically impossible to obtain figures which will give a fair comparison as to the life and the cost of maintenance of steel and wooden cars.[4] In the first place, although steel cars have been in general use since 1898, they are, generally speaking, still in first-class condition, and while the cost of repairing the bodies of the GI hoppers may be quite large, because of the weak design of center sills, this defect has been remedied on the later designed cars.

Thus far the matter of corrosion[5] has not become serious. While a number of the hopper sheets near the drop doors have rusted through, this is about the only part of the cars that has given serious trouble in this way, and such cases have been comparatively few. The cause of this corrosion seems to be that the moisture in passing down through the coal combines with the sulphur in the coal, forming a dilute sulphuric acid, which attacks the sheets and eats them much more rapidly than a stronger solution would. Where the cars are in constant service and are not allowed to lie on the side tracks the matter of corrosion is so slight as not to warrant consideration, but if the cars are not kept in constant use or are allowed to stand for any length of time with loads of coal or cinders, and these become damp, the sheets become more or less badly corroded. As all of the moisture in the cars drains off through the hopper doors, it does not come in contact with the underframes, and on all classes of steel cars these are practically in as good condition as when the cars were placed in service, as far as corrosion is concerned.

The life of a car will, of course, depend upon the service in which it is used. The floor and hopper sheets, in addition to being subjected to the above conditions, causing corrosion, receive more or less severe treatment while the cars are being loaded, especially where coal or ore is dropped from a tipple. It is estimated, however, that these sheets will not require renewal inside of 12 or 15 years from the time they are placed in service. Some of the more recently designed cars have floor sheets ¼ in. thick, while the side sheets, which do not deteriorate so rapidly, are only 3/16 in. thick.

It is variously estimated that the steel car will last from 1½ to 2 times as long as the wooden car and that during the life of the car the repairs to the body of the steel car will be less than those to the body of the wooden car during its life.

The indestructibility of the steel car may be judged from the fact that of the 47,775 all-steel cars now in service, 1,075 of which have been in use since 1898, only seven cars have been destroyed.[6] Two of these were lost in a flood in Kansas and most of the others were destroyed on foreign lines. It is quite probable that they would have been repaired and again placed in service if the damage had occurred on a road with facilities for handling steel car repairs. Of the 39,167 cars with steel underframes 66 have been destroyed. A large portion of these were box cars. Where the superstructure is badly damaged and catches on fire the underframe is often in such condition as to make it unwise to rebuild the car.

While the bodies of the steel cars cost less to maintain than do the bodies of the wooden cars, the wheels are much more expensive to maintain, because of the higher capacity of the steel cars. The limit of the cast iron wheel, at least as it is at present constructed, has been passed for the high capacity car, and there is an imperative need for a much better wheel. The steel car, because of its high capacity and the fact that it is handled more roughly than the wooden car, and that it is less elastic in itself than a wooden car, requires a stronger draft gear of high capacity.

THE PENNSYLVANIA SYSTEM FREIGHT CAR POOL.

On August 1, 1891, the various lines composing the Pennsylvania System formed a freight car pool. Each road keeps an accurate record of the amount of money spent for repairs to cars in the pool and the freight car mileage. Based on this mileage the cost of repairs is prorated among the different lines. In December, 1908, the Pennsylvania System had about 130,000 all-steel and steel underframe cars in service. This is about 53 per cent. of its equipment.

ORGANIZATION OF THE CAR DEPARTMENT AT ALTOONA.

The Altoona car shops and repair yards are in charge of a general foreman who reports to the division superintendent motive power. The various foremen reporting to the general foreman and his assistant are shown on the accompanying diagram, Fig. 4.[7]

[3] See page 157 of the May, 1907, issue.

[4] The Union Pacific System and the Southern Pacific Company have records of the cost of maintenance of a large number of steel and wooden cars of about the same age and capacity. These statistics, covering a period of 2½ years, will be found on page 270 of the July, 1907, issue. They show a large difference in favor of the steel car.
The comparative cost of repairing certain parts of steel and wooden cars on the Baltimore & Ohio is given on page 172 of the May, 1907, issue.
Data showing the relative cost of heavy repairs to steel and wooden cars on the Pittsburgh & Lake Erie Railroad will be found on page 408 of the October, 1908, issue.
Interesting data concerning the cost of repairing 50-ton steel hopper cars is given on page 17 of the January, 1907, issue.

[5] See page 157 of the May, 1907, issue.

[6] Similar information for the B. & O. is given on page 159 (second column) of the May, 1907, issue.

[7] This organization covers, in addition to the work of freight car repairs, the building of new freight equipment and the construction and repairs of passenger and other equipment cars, as well as the preparation of a large amount of supplies and repair parts for other shops.

In the steel car shop the foreman has an assistant and the force is divided into gangs, the various gang foremen reporting to the foreman and his assistant. This is also true of the freight shop.

The organization of the west bound repair yard, which is quite

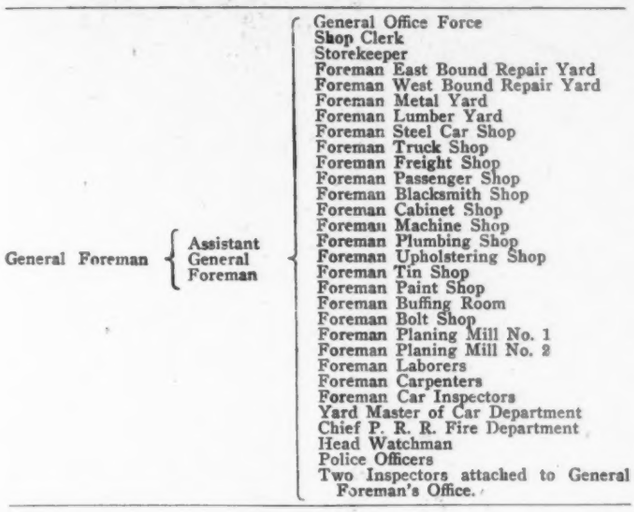


FIG. 4.—GENERAL ORGANIZATION OF THE ALTOONA CAR SHOPS.

similar to that of the east bound, is shown on the accompanying diagram, Fig. 5. It will be noted that while both the foreman painter and the storekeeper report direct to the general foreman, their representatives at the repair yard are also under the jurisdiction of the local foreman and his assistant, as is indicated on the diagram.

CARS REPAIRED AT ALTOONA DURING DECEMBER, 1908.

	STEEL CARS				WOODEN CARS	TOTAL OF ALL CARS
	Hopper	Gondola	Steel Under-Frame	Total		
East Bound Repair Yard	1,164	302	352	1,818	1,809	3,627
West Bound Repair Yard.....	1,106	195	326	1,627	1,898	3,525
Freight Shop....	116	84	206	406	1,420	1,826
Steel Shop.. ...	226	35	9	270	24	294
Total.....	2,612	616	893	4,121	5,151	9,272

STEEL CAR SHOP.[8]

The steel car shop is directly east of the freight shop, as shown on the general plan of the car shops, Fig. 2. It is 93 ft. wide by 553 ft. long, and has a steel frame, the roof consisting of slate on white pine sheathing, supported by 12 in., 25 lb. channels. The sides and ends of the building are covered with corrugated galvanized iron. As may be seen from the drawings and photographs, the windows form a large part of the side and end walls, furnishing splendid lighting. Additions near the middle of one side of the building contain the office, tool room and store room. The building is arranged so that, if necessary, extensions may be added on each side in the future. There is ample space for the storage of castings, steel parts and dies and formers at the ends and side of the shop.

THE EQUIPMENT.

There are three Shaw electric traveling cranes of 12½ tons capacity each. The width of the crane span is 87 ft. and the distance from the floor to the top of the crane run-way is 26 ft. Along one side of the shop and extending about two-thirds of its length a number of tools are arranged, which are used for new work only; these include two hydraulic riveters with a 10 ft. 6 in. gap, made by the Chambersburg Engineering Company. Also two hydraulic riveters of 50 tons capacity, with a 24 in. gap and a 6 in. stroke, made by the same company. There are three portable riveters of different types used in connection with a jib crane attached to one of the wall columns.

Two electric traveling hoists, having a capacity of 3 tons each and a lift of 16 ft. 6½ in. furnished by Pauling & Harnischfeger, operate on a run-way placed alongside the wall and underneath the large traveling crane run-way. These handle the material for the gap riveters. On the other side of the shop is a No. 2 rapid action, automatic stop Hilles & Jones punch, having a 20 in. throat and with a jib crane above it. Located near this is a radial drill. At one corner of the shop is an accumulator and a triple plunger single acting pump made by the Chambersburg Engineering Company, and having a capacity of 60 gallons per minute at a pressure of 1,500 lbs. per square inch. It is driven by a 65 h.p. motor geared direct to it. This pump and accumulator furnish hydraulic pressure for the riveters and also for a large press which has just been installed south of the shop (Fig. 10). This press is used to form the larger pressed parts used on both the freight and passenger car equipment. It was furnished by the Chambersburg Engineering Company and measures 10 ft.

[8] See January, 1908, issue for a description of the steel car repair shop at McKees Rocks on the P. & L. E. R. R.

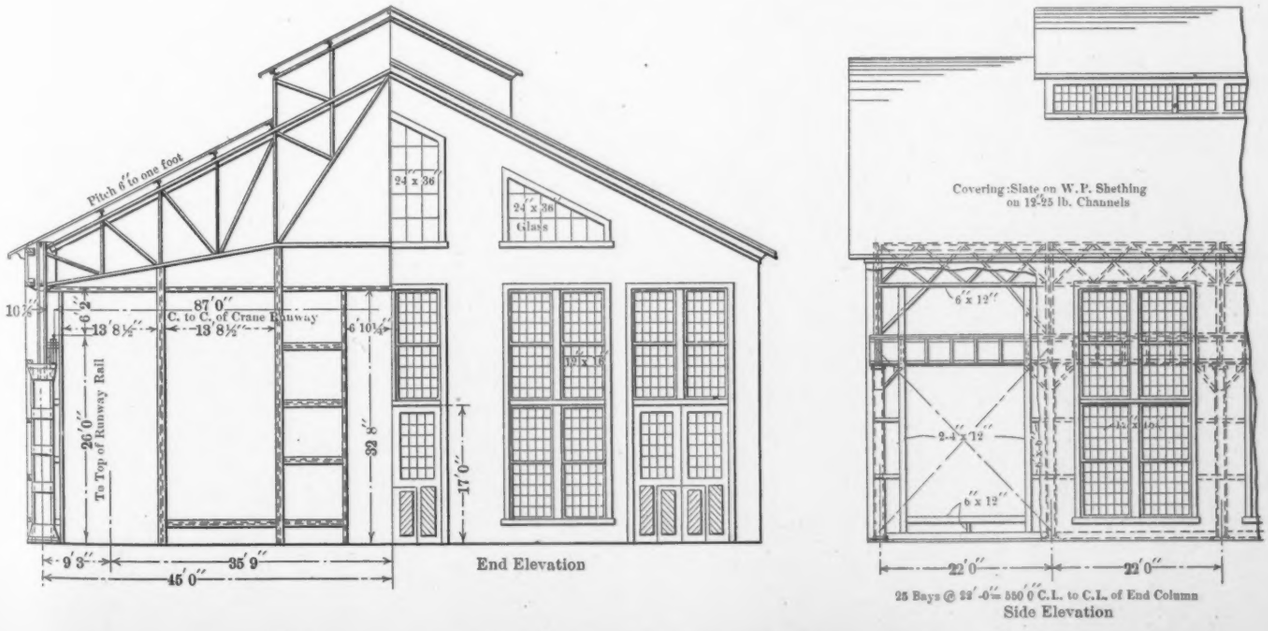


FIG. 6.—STEEL CAR SHOP AT ALTOONA.

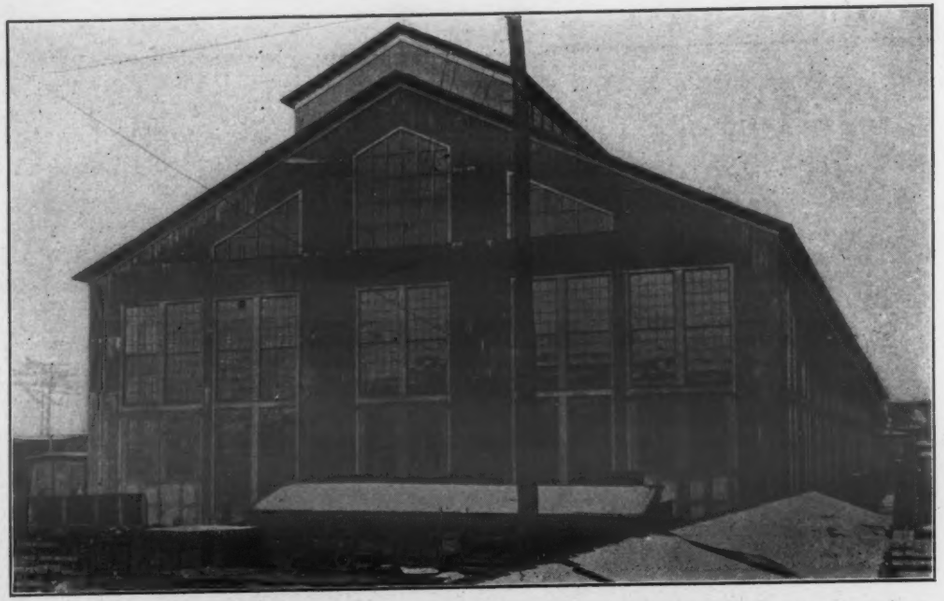


FIG. 8.—THE STEEL CAR SHOP, LOOKING FROM THE FREIGHT SHOP.

FIG. 7.—THE STEEL CAR SHOP, LOOKING FROM THE TRUCK SHOP.

FIG. 9.—INTERIOR OF THE STEEL CAR SHOP.

FIG. 11.—125-INCH GATE SHEAR FOR CUTTING LARGE SHEETS.

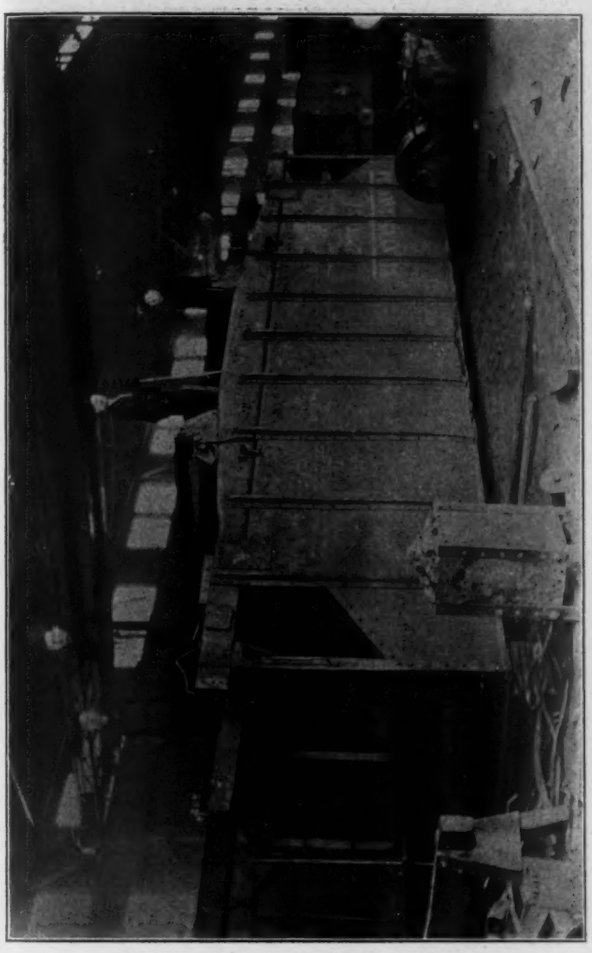


FIG. 14.—HOPPER CAR OVERTURNED AND MEN AT WORK ON CENTER SILLS.

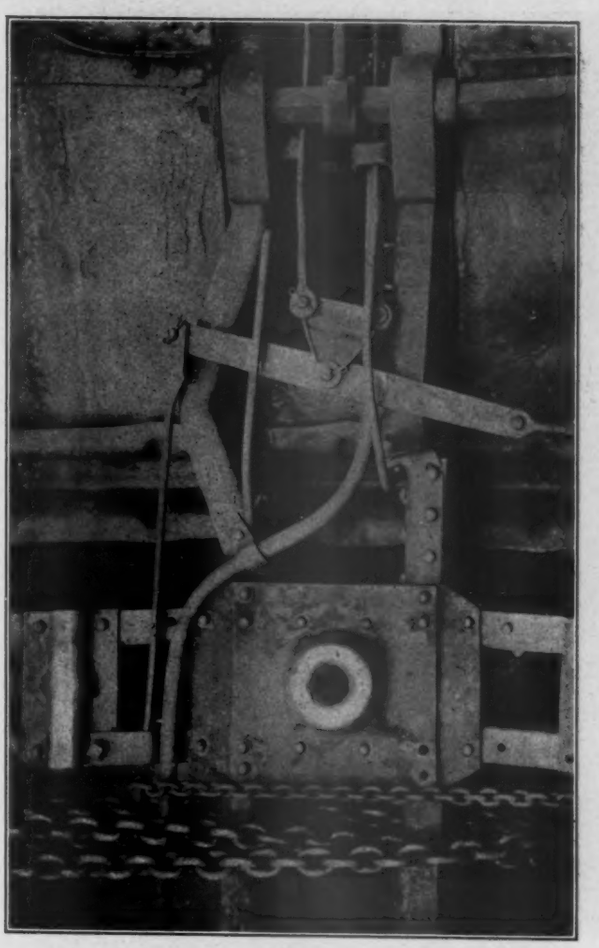


FIG. 15.—BUCKLED CENTER SILLS ON GL HOPPER CAR.

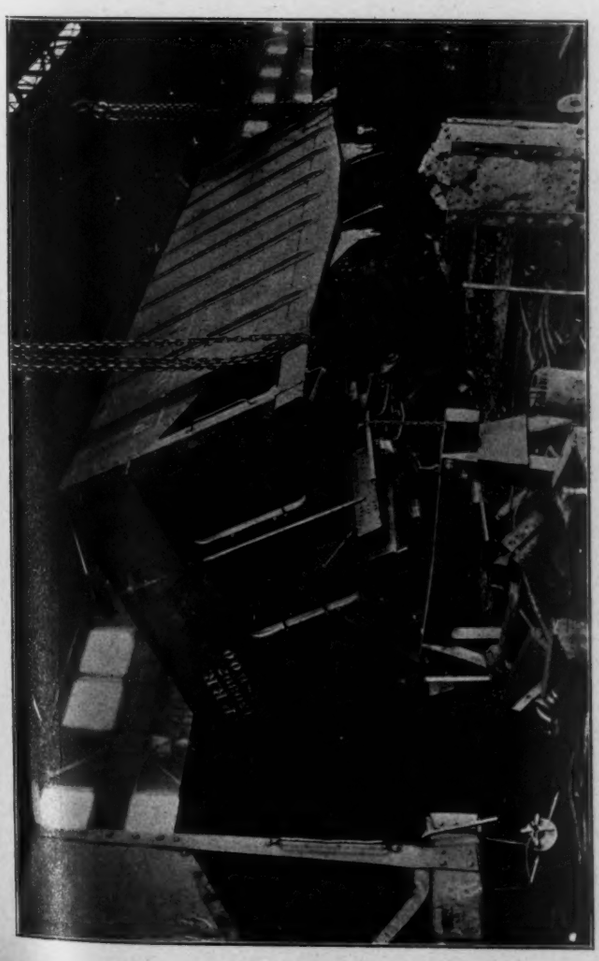


FIG. 12.—FIRST OPERATION IN OVERTURNING A HOPPER CAR IN THE STEEL CAR SHOP.

FIG. 13.—SECOND OPERATION IN OVERTURNING A HOPPER CAR.

FIG. 18.—CENTER SILL SPLICED ON GL HOPPER CAR.

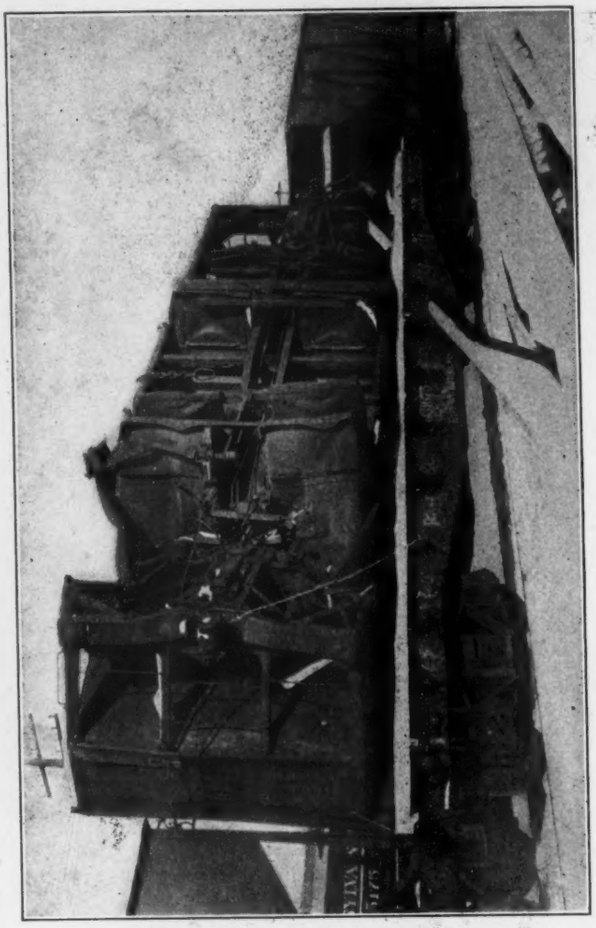


FIG. 19.—CAR BADLY DAMAGED AT ONE END WHICH WAS REPAIRED AT A REASONABLE EXPENSE.

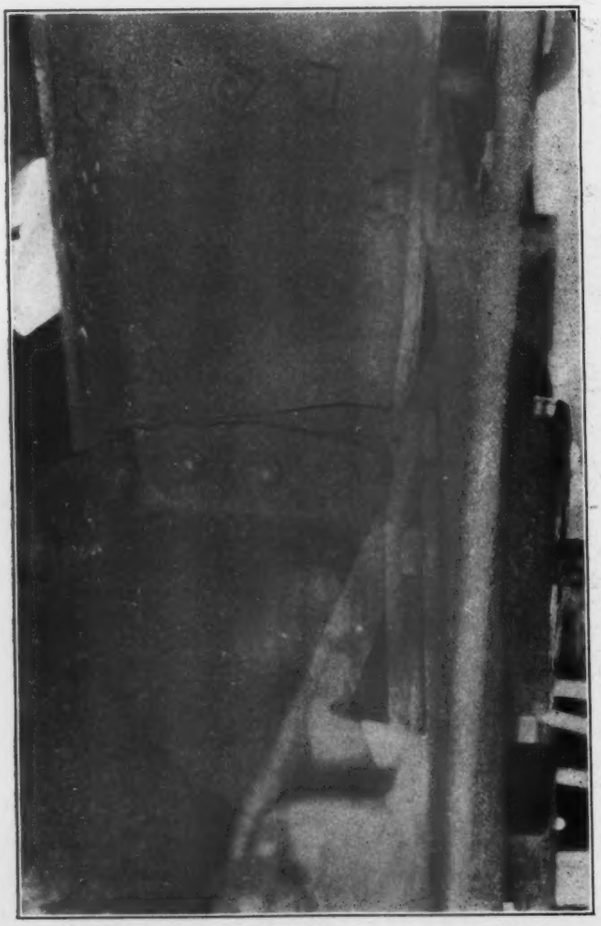


FIG. 16.—CRACKED CENTER SILL ON GL HOPPER CAR.

FIG. 17.—CRACKED CENTER SILLS REINFORCED ON A GL HOPPER CAR.

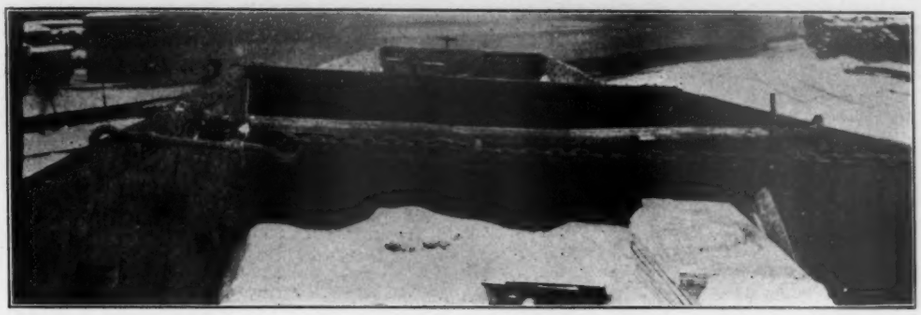


FIG. 21.—PULLING AND PUSHING DEVICES.

2 in. and 7 ft. 10 in. between the centers of the columns. It has a 42 in. stroke and is provided with a stripping ram having a diameter of 10 in. The press has three plungers, each of which exerts a pressure of 500 tons. The center one may be used alone, furnishing 500 tons pressure, or the two outside ones may work together, furnishing 1,000 tons pressure, or all three may be used at the same time, furnishing 1,500 tons pressure. The operating levers are so arranged that it is impossible to operate the plungers in any but these three combinations. Located near it is

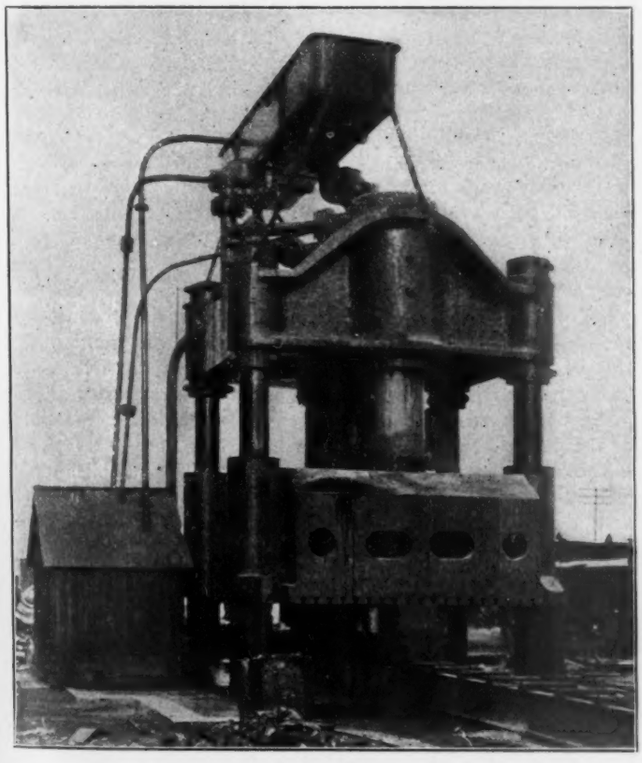


FIG. 10.—1,500-TON PRESS OUTSIDE OF STEEL CAR SHOP.

a Hilles & Jones No. 6, 125 in., gate shear (Fig. 11), used for trimming large size sheets to shape, such for instance as the pressed steel underframes for freight equipment.

How the Repairs Are Made.

As has been stated, only the heavier repairs to steel freight equipment are made in the steel shop. These consist quite largely in repairing buckled or cracked center sills on the GI hopper cars. In cases of this kind, or where extensive repairs are to be made to the underside of a car, it is turned up-side down, as shown by the accompanying photos. If the center sills are to be spliced the end sills and draft rigging are removed before the car is turned, as this work can be done to better advantage while the body of the car is in its normal position. Two of the traveling cranes are used to turn a hopper car. Chains are connected to one of the side sills at the bolsters and the car is turned over on its side (Fig. 12). The chains are then placed around the center sills (Fig. 13) and the car is lifted upward and is placed up-side down on blocks, as shown in Fig. 14. The workmen then climb to the top of the car and cut out the rest of the rivets and remove or splice the center sills, or repair the bottom of the hoppers with comparative ease.

The center sills of the car, which is shown being turned in the illustrations, were badly buckled back of the bolster. This is more clearly shown in the detail view, Fig. 15. The sills back of the other bolster were in practically the same condition. The two center sills were cut out and replaced with new sills, the old sills being sent to the blacksmith shop to be straightened out and cut into lengths suitable for splicing sills on other cars.

In many instances the center sills crack directly back of the bolster, as shown in Fig. 16. This is the weakest part of the sill and apparently the metal gradually gives away under the repeated stresses and finally cracks, starting at the bottom through the flange, which is weakened by the rivet hole, and gradually extending upward. In cases of this kind the body bolster is removed after the car has been turned up-side down and a ½ in. stiffening plate is riveted to the sill, as shown in Fig. 17. This, of course, means that the bolster diaphragm, extending from the center to the side sill, needs to be shortened to make up for the width of the plate. It is possible to do this by hand, but dies are being constructed so that it may be done better and more quickly. Where the sills are buckled back of the bolster the end of the sill is cut off and a new piece is spliced on as shown in Fig. 18.

A car, one end of which has been badly damaged, is shown in Fig. 19. The plates were straightened, new ends were spliced to the center sills and the other parts straightened, or repaired, and replaced. This was done at a very reasonable cost.

An interesting design of bolt is used for drawing up parts preparatory to riveting. The pitch is very large and the top and bottom of the thread are rounded off and are much broader than the standard thread. The nuts can be drawn up, or removed, much more quickly than on a standard bolt and the threads are not easily damaged. The ⅞ in. bolts have four threads to the inch and the ⅝ and ¾ in. five threads to the inch.

On repair work ten men work in a gang and two cars are assigned to each gang. On new work six men work in a gang. The tools used on the repair work will be considered at length in connection with the work of the west-bound repair yard.

When it is desired to turn a gondola car up-side down to do work on the under-side, three cranes are used. Chains from two of the cranes are passed about the draw bars at each end and the third crane catches a hook underneath one side of the car. When the two cranes have lifted the car a sufficient distance from the ground the third crane turns it over.

Most of the drawbar yokes used at Altoona are riveted to the couplers just outside the end of the steel shop. After the yoke has been placed over the end of the coupler a band is slipped over the yoke and a wedge is driven between it and the yoke, forcing the sides of the yoke tightly against the coupler. A block and screw jack are then placed between the coupler and the end of the yoke and the lugs are drawn tightly against the coupler. The rivets are driven while the coupler and yoke are held in this position.

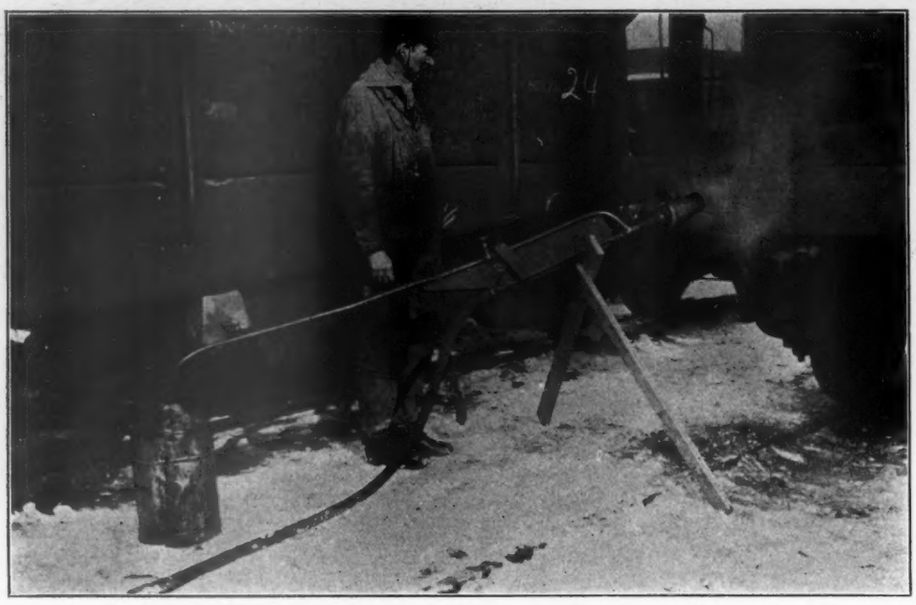


FIG. 20.—CRUDE OIL TORCH FOR HEATING DAMAGED PARTS.

Where sheets, or other parts of a car, are bent it is often possible to straighten them in place without removing them from the car. The parts may be heated locally by a crude oil torch,[9] shown in Fig. 20, and can usually be hammered back into place if not too badly damaged.

Fig. 21 shows two devices which are often used to advantage. The one in front consists of a chain with hooks which slip over the sides of the car, as shown. A turnbuckle at the left side, not shown very clearly, allows the sides of the car to be pulled inward. The device shown in the rear performs the opposite function and consists of a piece of heavy pipe with a screw jack arrangement at each end. With this it is possible to force the sides of the car outward and to hammer out any kinks. These devices may be used either separately or in connection with one another.

Parts which are badly bent or torn, and that cannot easily be hammered out straight on a face plate, are sent to the smith shop, where they are straightened under an air press, as will be described later. Meanwhile new parts are taken from stock for use on the damaged car. When the repaired parts are returned they are placed in stock.

The amount of steel freight car repair work done in the steel shop varies. If, as is the case at the present time, a large amount of new steel or steel underframe equipment is being built, only a comparatively small part of the shop is used for repair purposes.

WEST-BOUND REPAIR YARD.

General Arrangement.

The west-bound repair yard was not designed for this purpose, the distance between the track centers being only about 12 ft.; it is being used for this work temporarily, the idea being to transfer it later to a more convenient point near the East Altoona engine house. To provide room for buildings for the necessary offices, shops, storehouses and men's rooms, two of the tracks near the middle part of the yard are covered over. To one side of these temporary buildings is a running track and three tracks which are used for light repair work. On the other side are two tracks, used for heavy repair work, and a running track. To these may be added the parts of the two tracks not covered over at either end of the row of buildings. This provides room for over 300 cars.

The temporary buildings include a tool room and lumber storage shed; the office with a room for inspectors connected to it by a window; three rooms for the men, containing lockers, wash basins and time clocks; a room for storing paints and stencils; an oil room for the oil and waste; an air brake room; a blacksmith shop and a storehouse and storeyard.

How the Work is Carried On.

At one time when a large number of steel cars were regularly being brought in for repairs special gangs were detailed for this work, but during the past year or two this class of work has been lighter and at the present time there are only three steel car gangs, and they work on wooden cars as well. In event of a rush of steel cars they could be handled to advantage by the men in the other gangs. Each gang works under the direction of a gang leader and is composed of from 12 to 18 men.[10] The gang leader's duty is largely to order the necessary material and get it promptly to the cars, and to otherwise direct the work of the gang.

The men who work on steel car repairs are not boiler makers; in many instances they were repairmen on wooden cars, but after a little experience were able to do first-class work on the steel cars. Most of the work on the bodies of steel cars is done on a piece work basis, a certain amount being paid for each rivet which is cut and removed and for each new rivet driven and for each hole drilled or reamed. Where parts are slightly bent or damaged it is often possible to heat them with a torch and hammer them back into place without removing them from the car. Where it is necessary to remove the distorted parts they may often be repaired on a straightening press[11] in the repair yard and be replaced on the car. Where the parts are thus treated the men are paid on a time basis. Badly damaged parts which it is not thought advisable to try to straighten are loaded on a car and sent to the blacksmith shop. Here they are straightened[11] under a large air press, the men being paid on a piecework basis, at so much per 100 lbs. of material straightened.

When a car is placed in the repair yard an inspector makes note of the repairs which should be made on a form, known as M. P. 124, shown in Fig. 22. Any other work which may afterwards be found necessary must be referred to the inspector. On one side of this card he fills in the date, car number, initials and kind, the light weight, size of axles, and the account to which the repairs are to be charged, such as pool, foreign or M. C. B. On the other side he fills in the date and all of the columns except those showing the value of the material. The card is then placed alongside the springs on one of the trucks.

[9] In the repair yard of the B. & O. at Mt. Clair a fire is built about the damaged part, scrap wood being used (see page 167 of the May, 1907, issue). On the P. & L. E. R. R. at McKees Rocks a natural gas burner is used for this purpose, as shown on page 4 of the January, 1908, issue.

[10] The practice in this respect on the B. & O. and P. & L. E. R. R. is described on page 161 of the May, 1907, and page 6 of the January, 1908, issues, respectively.

[11] See page 162 of the May, 1907, issue.

M. P. 151

Pennsylvania Railroad Company

PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY
NORTHERN CENTRAL RAILWAY COMPANY
WEST JERSEY & SEASHORE RAILROAD COMPANY

1757 1-7-08 8¼ x 3¼

FROM.....

MATERIAL ORDER

TO..... 190

Ict. Acct. No.	Wt. or Quantity	DESCRIPTION OF MATERIAL	Price per Unit	

Enter on Each Card Items Chargeable to One Account Only

CHARGE TO.....

COMPLETED.....190 Foreman

FIG. 23.—MATERIAL ORDER FORM, M. P. 151.

The gang leader, to whose gang the car is assigned, orders the necessary material on form M. P. 151, which is reproduced in Fig. 23. When the work on the car has been completed he fills in his name on M. P. 124 and also the time the work was commenced and completed. The card and the work are then examined by the inspector and if found O. K., the card is signed and turned in to the shop clerk. Formerly it was the practice to enter all of the material used for repairs on the front of the card, but at the present time this is only done in the case of foreign cars. After the store department has checked the forms M. P. 151 and posted them on their books the originals are returned to the shop clerk and fastened to forms M. P. 124, to which they refer, after which they are filed. As may be seen,

M. P. 124 1470 K X 10-7-08 8¼ x 9¼

PENNSYLVANIA RAILROAD COMPANY.

PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY
NORTHERN CENTRAL RAILWAY COMPANY
WEST JERSEY & SEASHORE RAILROAD COMPANY

REPAIR CARD NO.....

.....190

To..... Gang Leader

Car No..... Initials..... Kind.....

Commenced..... Completed.....

Light Weight.....lbs. Size of Axles.....

Charge to.....

No. of Pieces	KIND OF MATERIAL	Weight or Quantity	Price per Unit	Credit

SEAL REPORT and DAMAGED LADING.

.....Foreman.

☞When Completed, Card must be promptly sent to SHOP CLERK.

FIG. 22.—FORM M. P. 124.

there is space on M. P. 124 for the seal report and notations as to damaged lading.

Time clocks are placed in the men's quarters, furnishing a record of each man's time. The gang leader is required to make out a summary card, Form M. P. 130, Fig. 24, from which the pay-rolls are made up. These summary cards must be turned in every few days and the shop clerk checks them up with the M. P. 124 forms. On the summary card is shown the number of the gang, the date, the name of the gang leader, the car number, initial and kind, or class; also the account to which it is charged, *i. e.*, pool, foreign, or M. C. B.; and the total amount due the gang for each car. At the lower part of the card the names of the members of the gang are shown, the number of hours put in by each man during the time covered by the summary report and the rate of each man per hour. From this data the shop clerk calculates the amount due each man. The rates of the men in the gang do not differ very greatly, except in the case of new men who are being broken in and have not yet become proficient, and of the gang leader, whose rate is slightly higher than that of the others.

TOOLS AND DEVICES USED FOR REPAIRS TO STEEL CARS.

The tool room is in charge of a man, who in addition to checking the tools in and out, keeps them in good condition and proper repair. There is also a man in the tool room who does the carpentry work, including the making of wheel-barrows, handles for various tools, etc. An interior view of a portion of the tool room is shown in Fig. 24a.

Hanging above the board, upon which the tool checks are placed, is a list of the classes of tools which are used, each one being numbered. The board is marked off by a number of ver-

REPAIRS REQUIRED.

.....190

.....Inspector.

Sills	Removed & Replaced	Truck & Brake	Frame	Cause of Damage	Class of Car ..... Cap'y of Car	Dolls.	Cents	Mills
					TOTAL.....			

FIG. 22A.—BACK OF FORM, M P. 124.

M. P. 130. 4½ x 8¼

1467 12 30 1907

PENNSYLVANIA RAILROAD COMPANY.

PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD CO.
NORTHERN CENTRAL RAILWAY CO.
WEST JERSEY & SEASHORE RAILROAD CO.

SUMMARY OF CARS REPAIRED.

No......

.....*190*

.....*Gang Leader.*

Car Number	Initial	Kind	Charge to	Amount

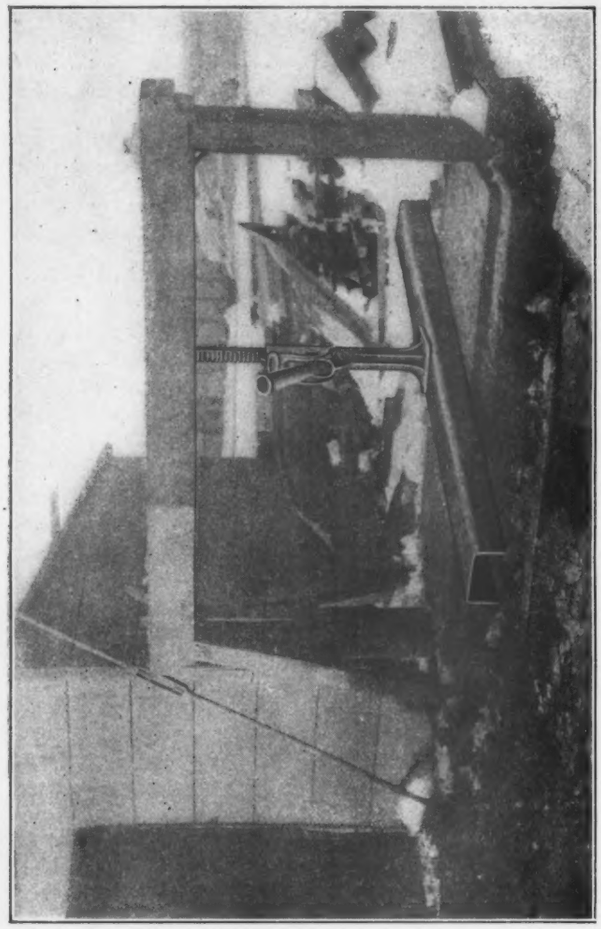


FIG. 28.—STRAIGHTENING PRESS AT THE WEST-BOUND REPAIR YARD.

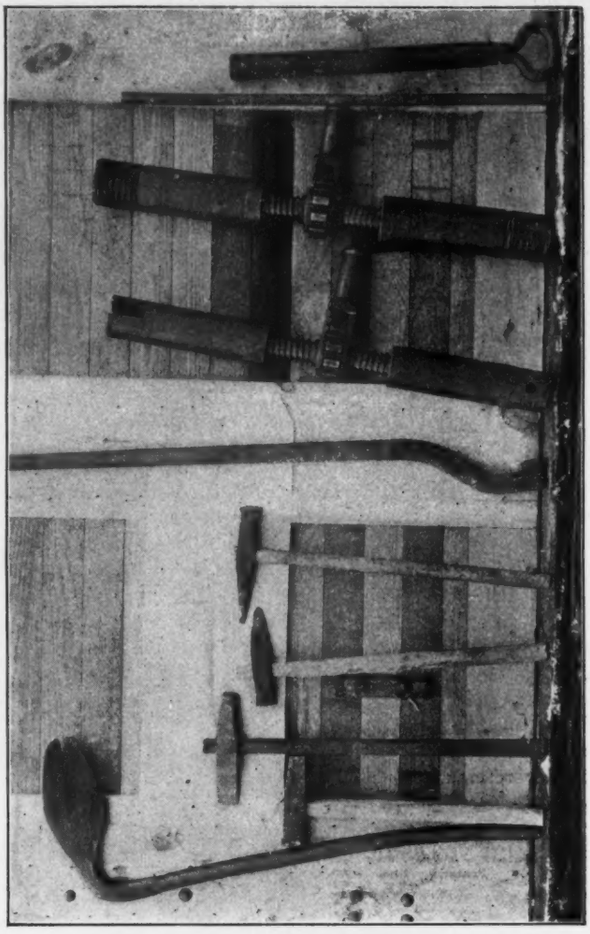


FIG. 26.—SOME OF THE TOOLS USED FOR REPAIRING STEEL CARS.

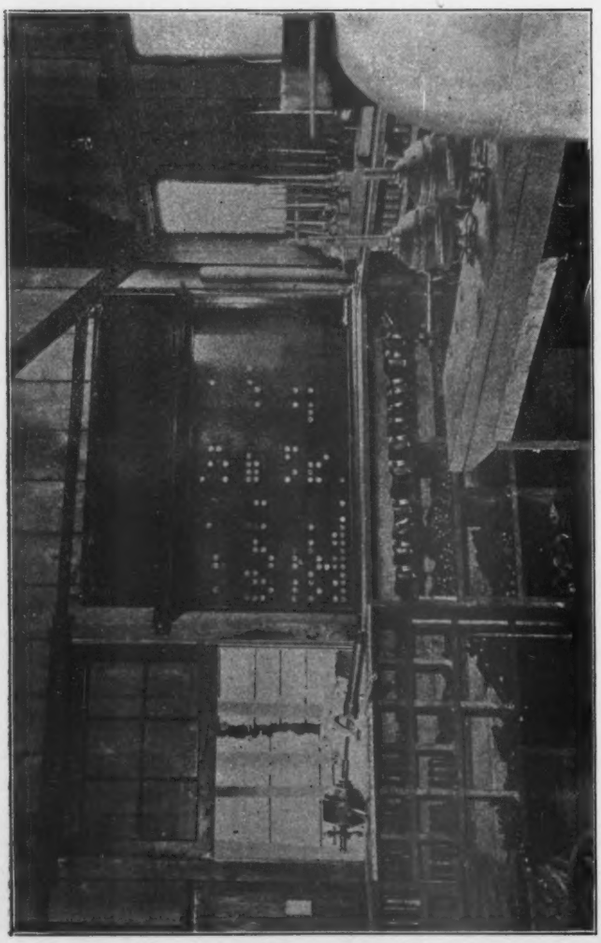


FIG. 24A.—INTERIOR OF TOOL ROOM AT WEST-BOUND REPAIR YARD.

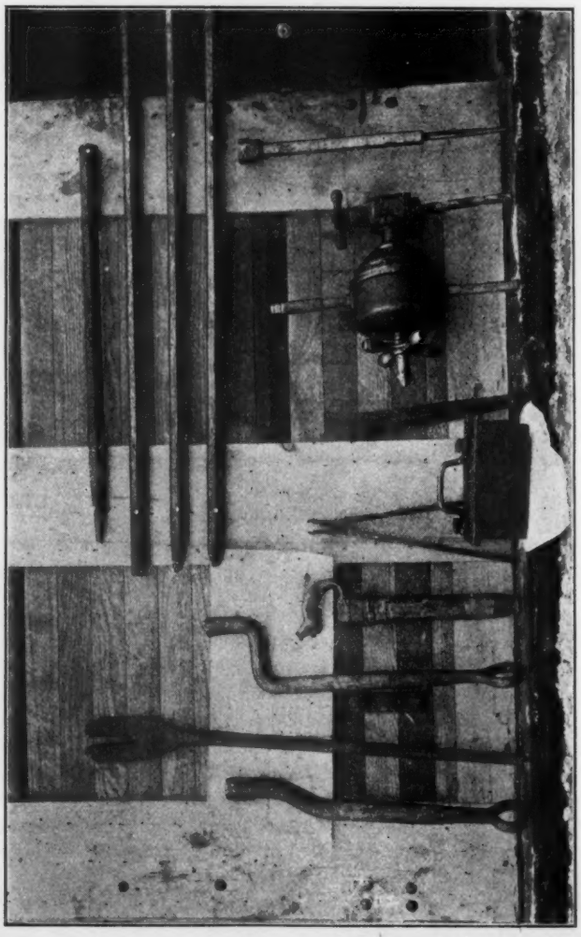


FIG. 25.—SOME OF THE TOOLS USED FOR REPAIRING STEEL CARS.

tical and horizontal lines, the spaces between the horizontal lines being numbered and designating the gangs and the spaces between the vertical lines also being numbered and designating the class of tool, as above referred to. In this way it is possible to find quickly how many and what tools each gang has. The tools are expected to be turned in every night. In addition to the tools which are listed in this way each man is furnished with a ball pein hammer and the necessary cold chisels, drifts and wrenches. These he keeps in a small tool box which he carries about with him.

The tools which are kept in the tool room and are used for steel car repairs are as follows:

Pneumatic Drills, for drilling and reaming holes, with the necessary drills and reamers.

Pneumatic Hammers and the necessary dies for driving rivets.

Air Hose for the pneumatic tools and for connecting the portable rivet heaters to the air line.

Sledges, 6 and 10 pounds.

Cutting Bars of various lengths and with different shaped cutting edges, as shown in the upper right-hand corner of Fig. 25.

Center Punches on handles as shown in Fig. 26.

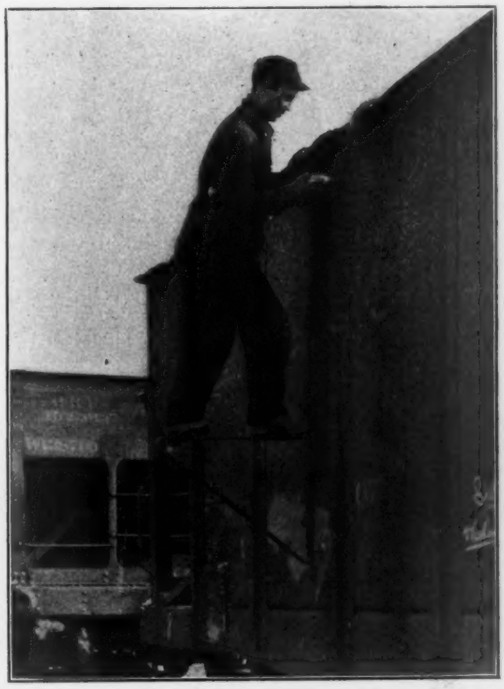


FIG. 27.—A SIMPLE AND CONVENIENT DEVICE.

Straightening Irons for grasping and bending sheets. One of these with a crooked handle is shown at the left in Fig. 26, and the other with a straight handle is shown near the left in Fig. 25.

A Block and Wedge, shown in Fig. 25. This is used for holding against the counter-sunk heads on the rivets used to fasten the draft castings to the sills on certain hopper cars. By means of the handle the block is held between the sills and the wedge is driven down, holding against the rivet head while the rivet is being driven.

Cutters on handles as shown near the left in Fig. 26.

Tongs for handling rivets, etc.

Rivet Punches for driving out rivets.

Drop Door Wrenches of various sizes for operating the drop doors.

Torches for lighting purposes and similar to those used on a locomotive.

Hydraulic Jacks of 15 tons capacity. These are kept in repair and issued from the tool room. There are also a number of ratchet jacks used.

Chucks or Expansion Bars for pneumatic drills, as shown to the right of the pneumatic drill in Fig. 25.

Pup or Journal Box Jacks.

Blowers or Torches.[9] One of these is shown in operation in Fig. 20. They are used for heating parts of the car which may be repaired or straightened without removing them from the car. The end or burner is made of a piece of 3 in. pipe about 8 in. long, which is screwed into a 3 in. to ¾ in. reducing sleeve. The ¾ in. pipe or nipple, fastened to this sleeve, connects to a ¾ x ⅜ x ⅜ in. T. The air, controlled by the globe valve, passes through the ⅜ in. pipe, which is reduced to ¼ in. at its upper end inside of the T, and syphons the oil through the other ⅜ in. pipe from the can, which is placed on the ground.

Clubs or Dolly Bars, also called holding on bars. Several shapes of these are shown in Figs. 25 and 26.

Cans with a Soda Solution for lubricating the drills and reamers.

Pulling and Pushing Jacks, as shown in Fig. 26. By using wooden blocks the side sheets may be pressed outward with the jack shown at the right, in the same manner as performed by the device shown in Fig. 21. Chains may be fastened by pins at each end of the jack shown to the left and the chain hooks may be thrown over the sides of the car and the sheets pulled inward.

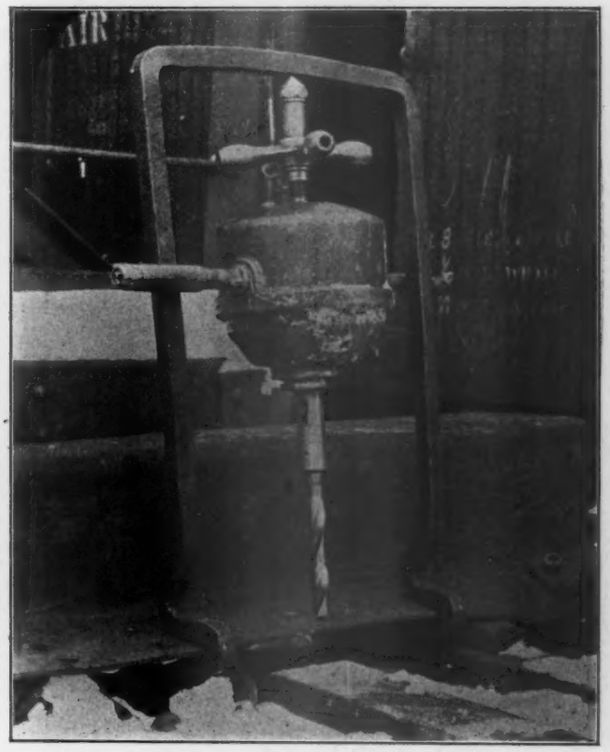


FIG. 29.—A SIMPLE BRACE FOR PNEUMATIC DRILLS.

An Angle Device used in connection with the pneumatic drills, making it possible to drill at right angles in places where it is impossible to use the standard drill.

These tools are used exclusively for steel car work and are in addition to the hand hammer, cold chisels, wrenches and drifts with which each man is furnished. As may be seen, some of the tools are of a very special nature and are only used occasionally, so that it is not necessary to have more than two or three of them for several gangs. In other cases, such for instance as pneumatic hammers, it would be necessary to provide one for every four or five men in a steel car gang.

Inasmuch as the number of steel cars in the repair yard varies greatly, so that often there is not enough work to keep more than one or two gangs engaged, while at other times there may be sufficient to keep several gangs going, it is impossible to make an estimate as to just what the tools for this work would cost per man, or per gang, but it is safe to say that a gang of five or six men could be very fully equipped with the necessary tools for less than $500.

In addition to the tools mentioned above there are several

FIG. 34.—REINFORCED BODY BOLSTER ON GL HOPPER CAR.

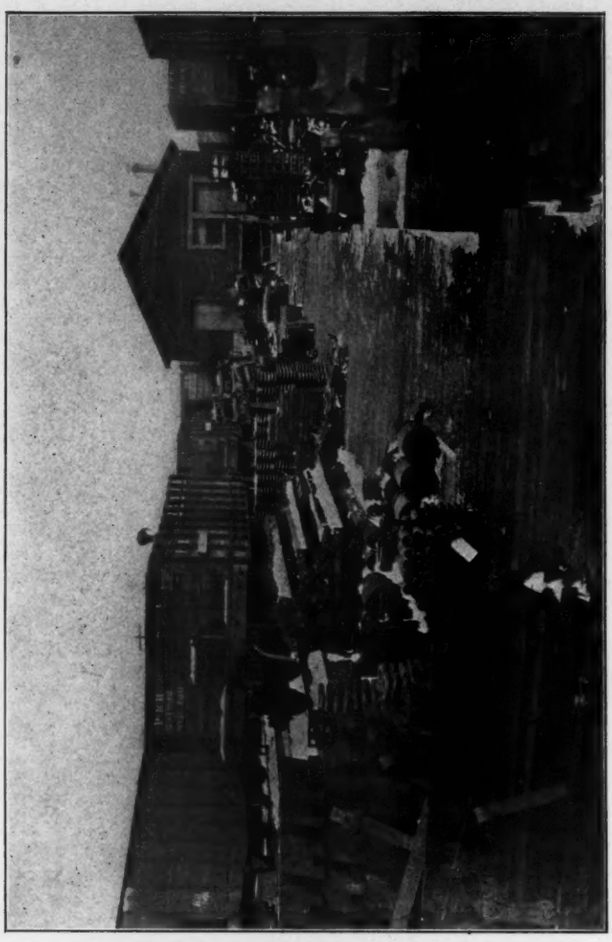


FIG. 30a.—STOREYARD—WEST-BOUND REPAIR YARD. MEN'S ROOM AT THE FAR END.

FIG. 30.—PORTABLE RIVET HEATER.

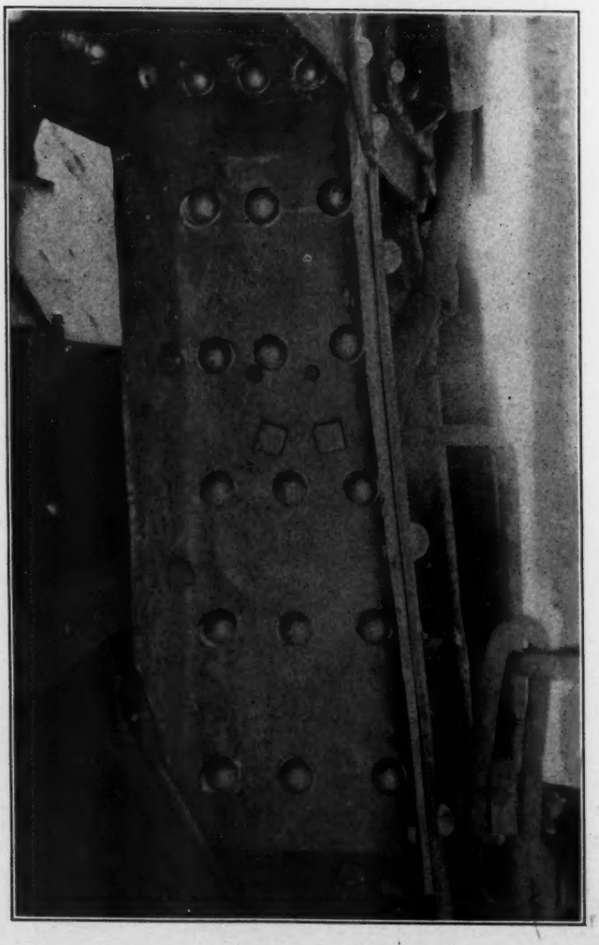


FIG. 31.—CENTER SILL SPLICE MADE AT THE WEST-BOUND REPAIR YARD.

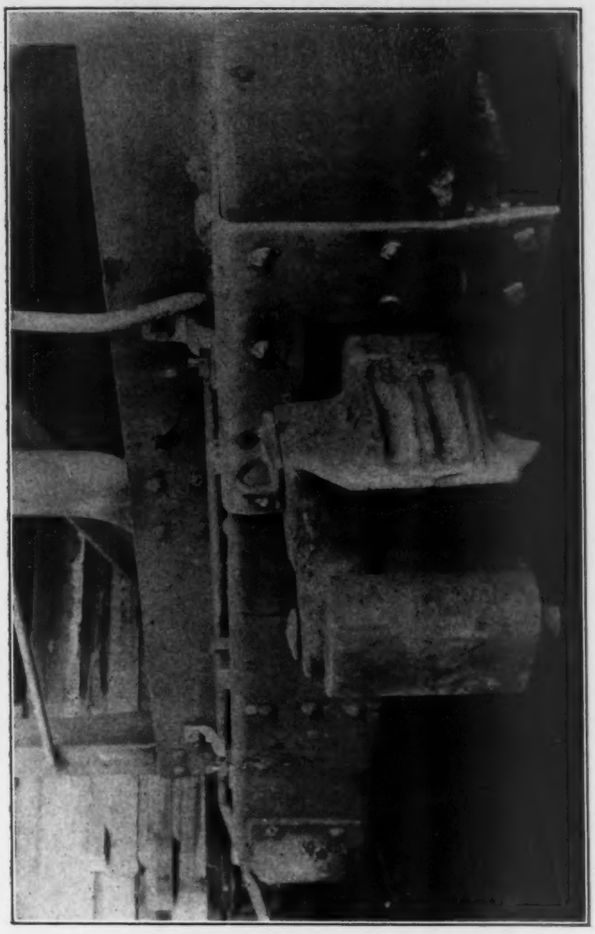


FIG. 33.—REINFORCED END SILL ON GL HOPPER CAR.

FIG. 32.—END SILL ON GL HOPPER CAR.

other special devices used in the repair yard in connection with the repairs to steel cars. One of these, shown in Fig. 27, is made of wrought iron, the top fitting over the side of the car. The workman is holding a "dolly bar" or "holding on bar" against a rivet, which is being driven from the other side of the sheet. By using two or more of these brackets and placing planks upon the horizontal portions a platform may be erected along the side of the car.

In the west-bound repair yard are two straightening presses, one of which is shown in Fig. 28. These consist of a wooden framework reinforced and tied together by iron rods and attached to a base of timbers upon the top of which a cast iron plate is placed. Bent or distorted pieces may be pressed into shape by the use of ratchet jacks, as shown, and by hammering the pieces into shape with sledges. An open forge, not shown in the photo, is at the left and is used for heating the parts.

Fig. 29 shows a brace that is very convenient for drilling or reaming holes. These braces are made in a variety of shapes for getting at inconvenient places on the car.

A portable rivet heater[13] is shown in Fig. 30. The cast iron pot is about 1½ in. in thickness and measures 12 in. inside diameter at the top. It has a hole 6¼ in. in diameter at the bottom in which a small grate fits. The plate upon which the pot rests is 2 ft. square and is of cast iron. The lower portion, cast integral with the plate, has a cavity 5 in. square and 9 in. deep, near the top of which the air enters from the air hose and into which the ashes fall, being removed by a slide at the bottom.

THE STOREHOUSE AND THE PARTS CARRIED FOR STEEL CARS.

Because of the temporary location of the west bound repair yard the store room is only large enough to hold the bolts, rivets and smaller material. The larger material is arranged on a platform just outside. A tin pocket is attached to each box or bin containing material and in it is a card showing the date and the amount of material received at various times; also the amount and date of all lots of material issued. It is thus possible to find quickly the exact amount of material on hand and also the rate at which it is being withdrawn.

Very little new material is required for repairs to the bodies of steel cars, but a certain amount is carried in stock to replace parts which are sent to the blacksmith shop for straightening, or to reinforce or strengthen the weak parts on the Gl cars. In examining the store house stock the following parts for bodies of steel cars were found:

Center Sill Splices.[13] These are for the Gl cars and are similar to those described on page 91, in connection with the work in the steel car shop. It is interesting to note that the Gl cars are the only ones on which the center sills give trouble, the Gla cars, which were designed later, giving splendid results in this respect. This is probably due to the increased sectional area of the center sills of the Gla cars; the trouble with breakage was one of the main reasons for making the increase. Gl cars with cracked or buckled center sills are very often received in the west bound repair yard and the sills are spliced in the same way as in the steel shop. A center sill splice made in the repair yard is shown in Fig. 31.

End Sills. The end sills of the Gl hopper cars are damaged when the center sills are buckled. If badly damaged they are straightened on the straightening press in the yard or sent to the blacksmith shop. In the latter case an end sill is taken from stock, so as not to delay repairs to the car.

End Sill Stiffening Plates.[14] On the Gl hopper cars the coupler carrier iron is supported by two plates riveted to the end sill, each side of the coupler, as shown in Fig. 32. Where the end sill is damaged at the center these plates are often removed and replaced by a large single plate, as shown in Fig. 33. This reinforces and strengthens the sill.

[13] See page 4 of the January, 1908, issue for a portable rivet heater used on the P. & L. E. R. R.

[13] The method of splicing center sills of steel hopper cars on the B. & O. is shown on page 171 of the May, 1907, issue.

[14] The application of end sill reinforcing plates to B. & O. cars is shown on page 168 of the May, 1907, issue.

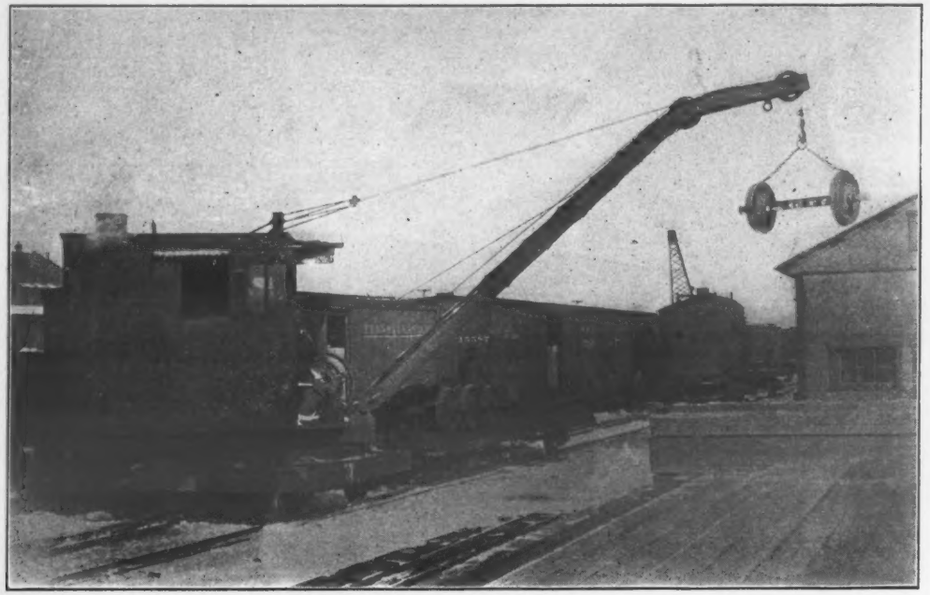


FIG. 36.—LOCOMOTIVE CRANES USED IN REPAIR YARDS.

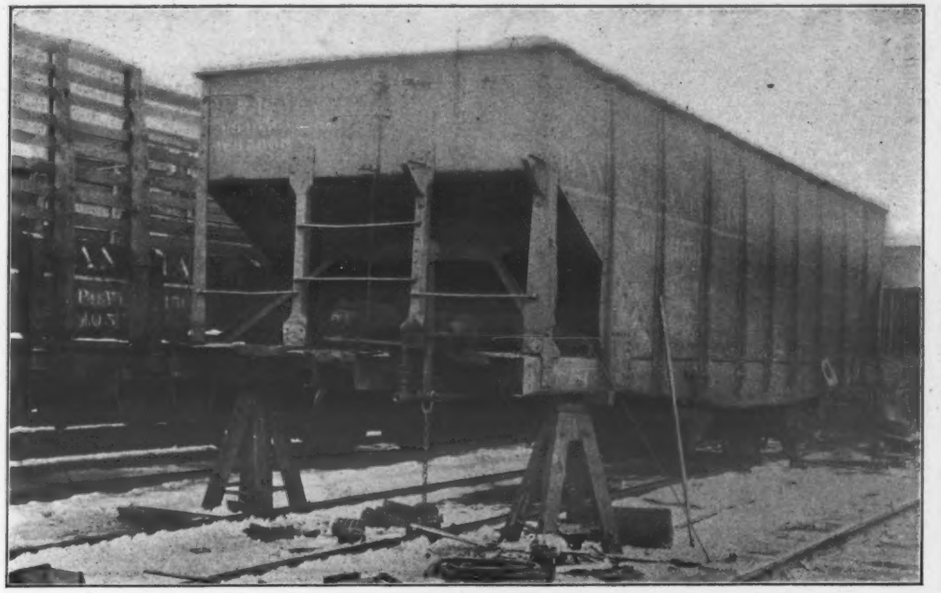
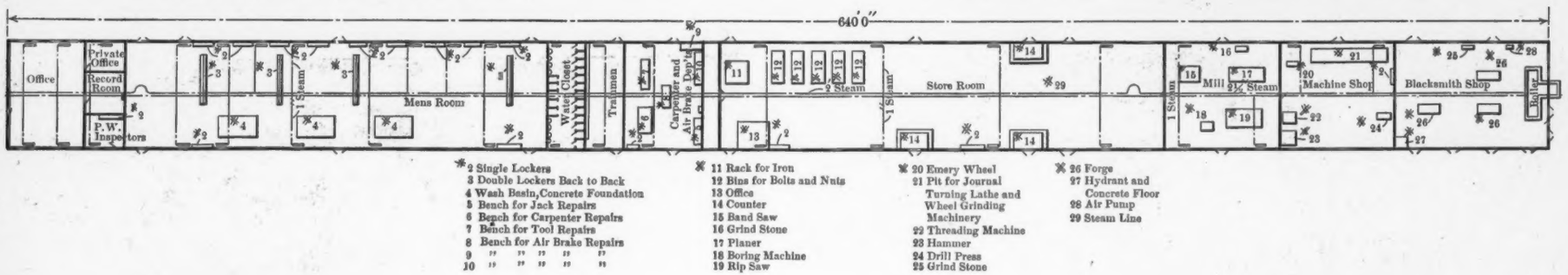


FIG. 35.—SUBSTANTIAL TRESTLES FOR SUPPORTING CAR BODIES.

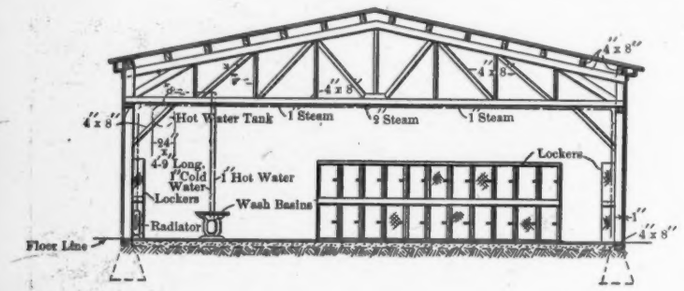


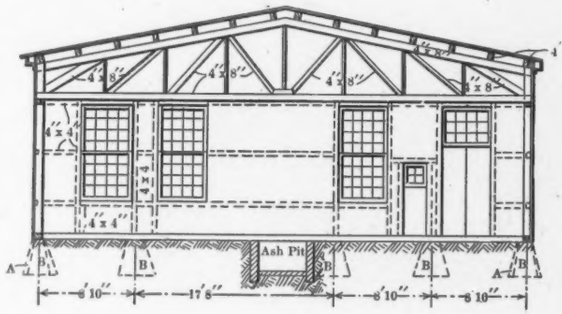
* 2 Single Lockers
3 Double Lockers Back to Back
4 Wash Basin, Concrete Foundation
5 Bench for Jack Repairs
6 Bench for Carpenter Repairs
7 Bench for Tool Repairs
8 Bench for Air Brake Repairs
9 " " " " "
10 " " " " "

* 11 Rack for Iron
12 Bins for Bolts and Nuts
13 Office
14 Counter
15 Band Saw
16 Grind Stone
17 Planer
18 Boring Machine
19 Rip Saw

* 20 Emery Wheel
21 Pit for Journal Turning Lathe and Wheel Grinding Machinery
22 Threading Machine
23 Hammer
24 Drill Press
25 Grind Stone

* 26 Forge
27 Hydrant and Concrete Floor
28 Air Pump
29 Steam Line





ARRANGEMENT AND CONSTRUCTION OF THE BUILDING AT THE EAST-BOUND REPAIR YARD.

Side Stakes. These are sometimes damaged or torn off when a car receives side swipes or is otherwise badly damaged.

Corner Posts. These are sometimes badly damaged on the hopper cars and a small supply of new ones is carried in stock.

Bolster Stiffeners. The Gl cars were equipped with trucks having pressed steel bolsters. The center plate was pressed in the top cover plate. This plate was not properly reinforced underneath the center and after the cars had been in service for several years the center plate was forced downward, thus bringing the side bearings down and throwing the greater part of the weight of the body on them. This tears or distorts the lower flanges of the body bolster members to which the side bearings are riveted. When a car comes to the repair track in this condition the top member of the truck bolster is cut off and is replaced by a new plate and a cast steel center plate. The distorted flanges of the body bolster, are forced back into position and are reinforced by ½ in. angle plates, as shown in Fig. 34.[18] In some instances the side bearings are badly damaged and a stock of these is carried at the store house. This trouble has been corrected on the later cars by a change in the design of the bolsters.

The Cross Ties connecting the sides of the Gl hoppers consist of corrugated plates, the ends being riveted to the sides. They are placed vertically so as to offer the least resistance to the coal or other material which may be dropped into the car. This construction is not very strong and it is often necessary to replace the plates. On the Gla cars this cross tie is made up of two plates, with a V pressed in them, riveted together, thus forming a box section which is much stiffer and not so easily damaged as the plate on the Gl cars. (See page 148, May, 1905, issue).

Hopper Doors are sometimes badly damaged and the various parts of these doors are carried in stock. The same may be said concerning certain parts of the draft rigging.

OTHER EQUIPMENT.

An important and commendable feature in the repair yard is the trestle for supporting the car, shown in Fig. 35. These are about 40 in. high and are made of 4 x 4 in. planks with a 2 in. plank, 10 in. square, at the top. The timbers are securely bolted together. These trestles eliminate any possibility of such accidents as sometimes occur when cars are supported on barrels or where a lighter trestle is used, or where the ratchet jacks, with a narrow base, are left to perform this duty.

Two 15-ton locomotive cranes, one with a boom 45 ft. long and the other with one 29 ft. long, are used for handling the wheels and axles in and out of the trucks and for the lifting back and forth of heavy parts. These cranes are shown in Fig. 36 and were furnished by the Browning Engineering Company, of Cleveland, O., and the Bay City Industrial Works, of Bay City, Mich.

The blacksmith shop contains a 100-pound Shaw & Justice power hammer and a two-spindle 1½ in. bolt cutter.

EAST BOUND REPAIR YARD.

GENERAL ARRANGEMENT.

Most of the repairs made at the east bound repair yard are to loaded cars or cars from which it has been necessary to transfer the lading. Only light repairs are made to steel cars. The yard has been carefully arranged and equipped to handle the work to the best advantage. The building in which the offices, store house, men's quarters and shops are placed is substantially built and splendidly arranged, both as to facilities for performing the work and for the comfort and convenience of the workmen.

The repair tracks are laid out with plenty of distance between centers and a system of narrow gauge tracks extends throughout the yard, over which supplies may be carried on push carts. The tracks are spaced about 16 ft. center to center; between every other track is the narrow gauge track for carrying supplies, the repair track centers in this case measuring about 19 ft. center to center. There is a narrow gauge cross track, with turntables, near the center of the yard. The space between the tracks throughout the yard is covered with heavy planking, the timbers being taken from cars which were destroyed at the metal yard, which lies just west of the repair yard.

For transfering coal, coke or similar material from damaged cars there is an unloading trestle with capacity for holding five cars. For transferring loads in box cars two tracks are placed so that there is only about 22 in. space between the cars. One of the tracks is placed about 14 in. lower than the other, so that heavy pieces of machinery, or other material, may be more easily transferred. A depressed track into which gondola cars are run makes it possible to conveniently and cheaply load the scrap and refuse material.

THE BUILDING.

The building containing the offices, men's rooms, shops, etc., is of special interest, since, although it is substantially built and conveniently arranged, the timbers from which the frame is made were practically all taken from wooden cars which were assigned to the metal yard for destruction. The ground upon which it is built is filled in and it rests upon concrete piers. Underneath the floor is a layer of ballast and the floor timbers are planks taken from old freight cars. The roof is covered with four-ply slag, and the sides with white pine sheathing and battens. The building is 45 ft. wide and 640 ft. long.

Referring to the plan showing the arrangement it will be seen that a large office is placed at one end, having a private office and a record room in connection with it. The piece work inspectors' room is next to the office and has three small openings connecting into it. On each side of these windows, or openings, are wire baskets. The piece work inspectors pass the repair cards, M. P. 124 (see page 93), through the first one of these openings when they refer to repairs which are to be billed against foreign roads. The clerk, in the office on the other side, makes out the M. C. B. cards and attaches the ones which are to be placed on the cars to the repair cards and passes them back through the second opening. When the inspector has checked these and placed the M. C. B. cards on the car the repair cards are returned through the third opening.

The most interesting part of the building is the men's room, which is 176 ft. long, an interior view being shown in Fig. 37. In this are placed large expanded metal lockers. A number of long tables, with benches, are provided at which the men eat their lunches. These tables are fitted with drawers, in which the gang leaders may keep the material for the reports which they must make out. There are a number of wash basins with hot and cold water faucets. Underneath and about these basins the floor is of concrete, draining toward the center. Near either end of the room are two time clocks, where the men register. This room, like the rest of the building, is well heated, steam for the radiators being furnished from the boiler at the end of the smith shop.

Adjacent to the men's room is a lavatory. A room is provided for the trainmen who may be stationed in or near the repair yard. Next to the room which contains the carpentry and air brake departments is an opening or tunnel through the building through which material may be carried over a narrow gauge track. All of the stock material is kept under cover, the store room being 144 ft. in length. It is very neatly and conveniently arranged, as shown by the photograph, Fig. 39.

The next section contains the wood working machinery, including a band saw, planer, boring machine, rip saw and grind stone. The machine shop contains two gap lathes for turning the journals without removing the wheels and also a Norton grinding machine for grinding out the flat spots on cast iron car wheels. There is also an emery wheel, a bolt threading machine and a drill press. In the blacksmith shop are several forges and a boiler which supplies heat and power for the plant.

Located a couple of hundred feet from the main building is a smaller one for the use of the painters and stencilers and for the storage of oil and waste.

[18] On page 170 of the May, 1907, issue is shown the method of repairing and reinforcing the body bolsters, as used at the Mt. Clair shops of the B. & O.

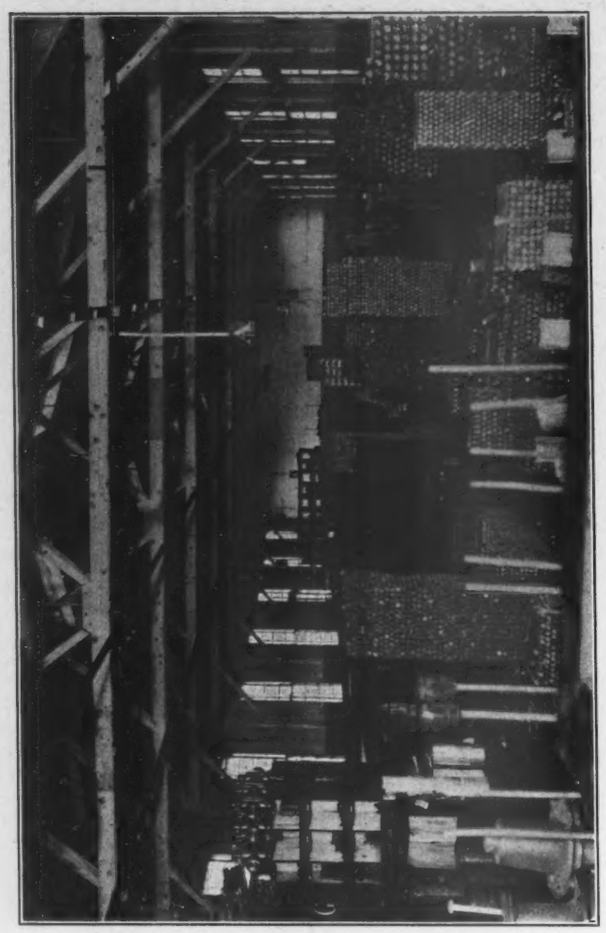


FIG. 39.—STOREROOM, EAST-BOUND REPAIR YARD.

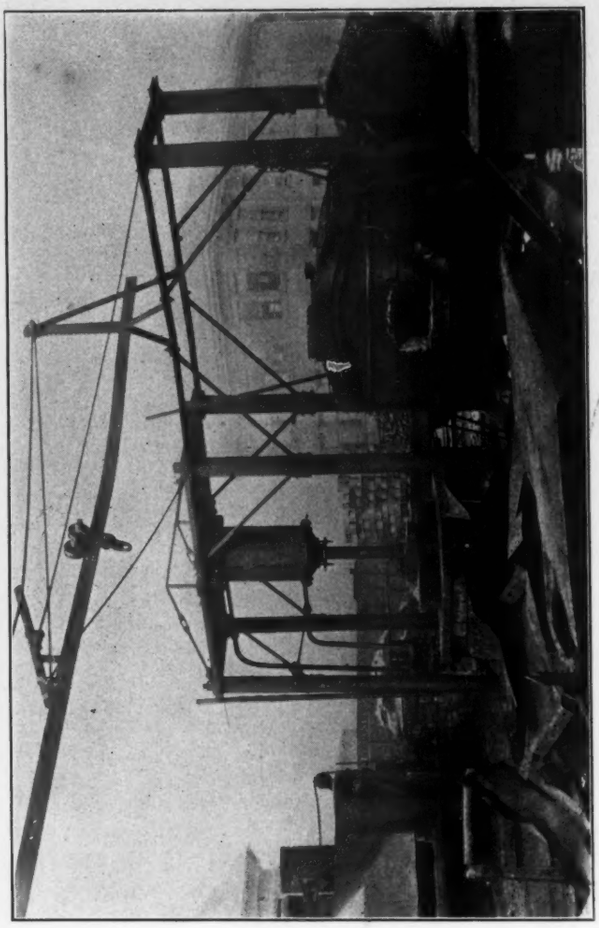


FIG. 40.—ONE OF THE STRAIGHTENING PRESSES, BLACKSMITH SHOP.

FIG. 37.—MEN'S ROOM, EAST-BOUND REPAIR YARD.

FREIGHT SHOP.

The freight shop was built many years ago and is in the form of a round-house, the outer circle of which is 434 ft. in diameter, and having an open inner space 285 ft. in diameter, containing a 105 ft. turntable. The turntable is driven by a steam engine, and a small switch engine does the shifting. The width of the building inside is about 65 ft. It has 40 divisions or spaces. Thirty-four of these are used for repair purposes; three are in the form of tunnels and are used as running tracks; the remaining three divisions have two tracks only, and the space about them is devoted to the stores department for the storage of stock. Rivet heating forges are placed alongside two or three of the tracks upon which repairs to steel cars may be made. Cars are also repaired in the open space between the building and the turntable.

STRAIGHTENING PARTS AT THE BLACKSMITH SHOP.[18]

The badly damaged steel parts are taken from the steel car shop, the freight shop and the west bound repair yard to the smith shop for straightening. This is done under a pneumatic press, which is shown in Figs. 40 and 41. A frame-work supports the 20 in. air cylinder. Underneath the cylinder is a foundation upon which a cast iron table, 6 in. thick, 4 ft. wide and 7 ft. long, is placed. The air in the cylinder is controlled by a pneumatic four-way valve at one side of the frame work.

There are two of these presses just outside one end of the blacksmith shop. With the aid of a few cast iron blocks and two or three men to handle and hammer the sheets it is possible to straighten any part of the car and bring it back to its original shape. This work is done by piece work, the men being paid a certain rate per 100 pounds of material straightened. It is remarkable how adept the men become in doing this work. At one

[18] At the Mt. Clair yards of the B. & O. this work is done in what is known as a flange fire shop, as described on page 162 of the May, 1907, issue.

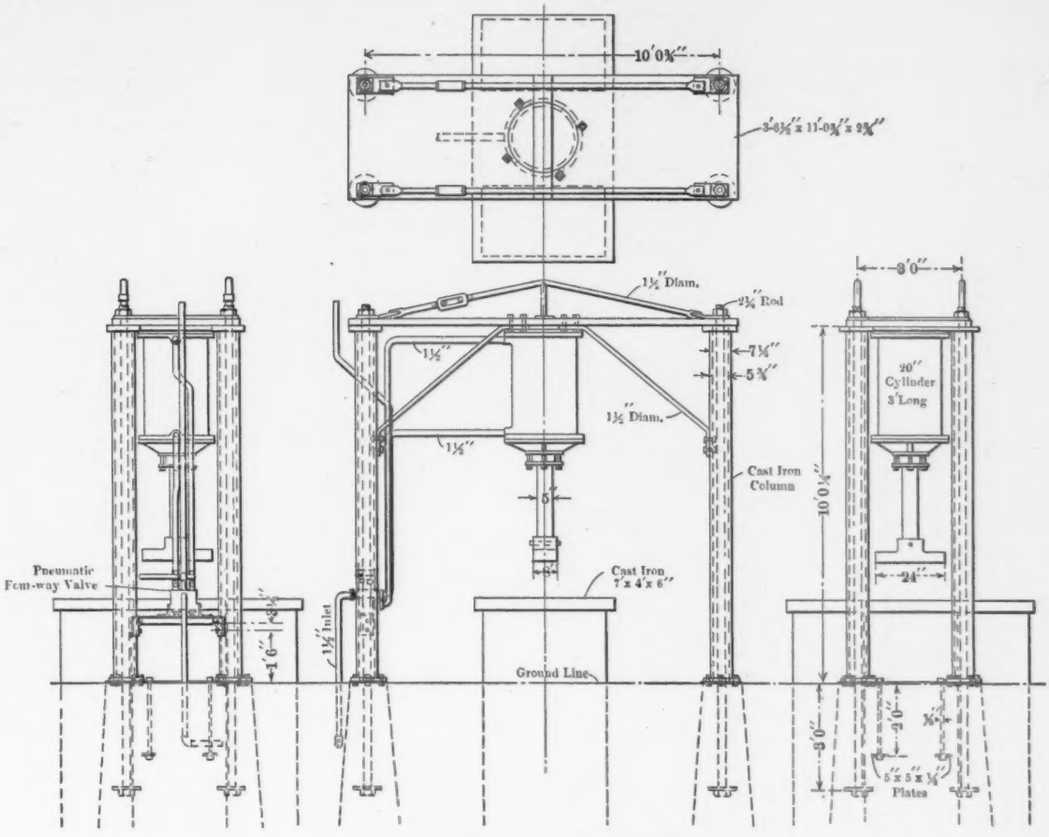


FIG. 41.—STRAIGHTENING PRESS, BLACKSMITH SHOP.

side of the press is a special oil furnace, with an opening 30 in. wide and 15 in. high, through which long material may be passed and any part of it heated locally. On the other side of the press is a large oil furnace for heating other parts. It has an opening 8 ft. wide and 21½ in. high at the center and is about 10 ft. deep.

REPAINTING STEEL CARS.[17]

The question of repainting steel cars—how often they should be repainted and how it should be done—is a troublesome one. The inside of the car corrodes or deteriorates more rapidly than the exterior. The rapidity or extent to which this takes place depends upon the service to which the car is subjected. Where the car is in constant service and is not allowed to stand idle it is very slight. When allowed to stand with loads of coal, coke or cinders, especially during damp weather, it is more serious Experiments have been made to find some covering which would protect the interior of the car, but such materials as have been experimented with are quickly worn off by the friction of the lading.

The deterioration on the outside does not appear to be at all serious, the most notable instances of corrosion being opposite the hoppers at points where they have apparently been pounded with hammers or bars to loosen the lading. Frequent painting of the car would not do much good under such treatment. As the paint wears or flakes off the sheets become rusted, but it is a question as to whether the coat of rust does not to some extent protect the sheets. The underframes are protected from drippings from the inside of the car and where they were properly painted when they are built, are practically in as good condition as when they were first placed in service, although some of them are more than ten years old.

It would, therefore, appear that it is comparatively useless to repaint the interior of the car and that the necessity for repainting the exterior depends more on the appearance than on the effect which it would have on the life of the sheets. Surely it would not be policy to withdraw a car from service during busy times for repainting because of any increase in the life of the sheets which might result.

If the appearance of the cars is to govern the length of time before repainting them, the uncertain question as to just what will constitute a good appearance must be considered. If the appearance is to be first-class the car should be painted about once in three or four years, as against once in six or seven years for a wooden car. The expansion and contraction of the material, due to changes in temperature, the loading of the cars with hot cinders, and the fact that the paint does not adhere so readily to the steel as to the wood, makes repainting necessary more often than is the case with wooden equipment. As a matter of fact cars are running which have not been repainted since they were placed in service, six, seven, eight, nine, and even ten years ago.

At each of the car repair points in Altoona is a gang of painters, in charge of a gang leader, who look after the stenciling of the cars which are repaired and the painting of new or repaired parts. These men work by piecework, being paid a certain rate per square foot for painting and so much per letter for stenciling. The gang leaders report direct to the assistant paint foreman.

Where it is desired to repaint a car complete it is taken to the freight car paint shop, which is 109 x 512 ft. in size, and contains six tracks. Here the underframe and the body of the car are painted by a spraying machine. These machines consist of a tank, having a capacity of about 10 gallons, placed in a framework which may be wheeled about the shop. The arrangement of this apparatus and the details of the atomizer are shown in Fig. 42. The advantage of this type of spraying machine is that the atomizer is at the tank and only one hose extends from it to the car.

A visit to the paint shop showed that there was very little surplus paint on the ground about the car. The spraying machine has several advantages. Both labor and material are saved and better work is done. On a Gl hopper car only two-thirds as

[17] See also page 19 of the January, 1907, issue; page 178 of the May, 1907, issue; page 6 of the January, 1908, issue; and page 408 of the October, 1908, issue.

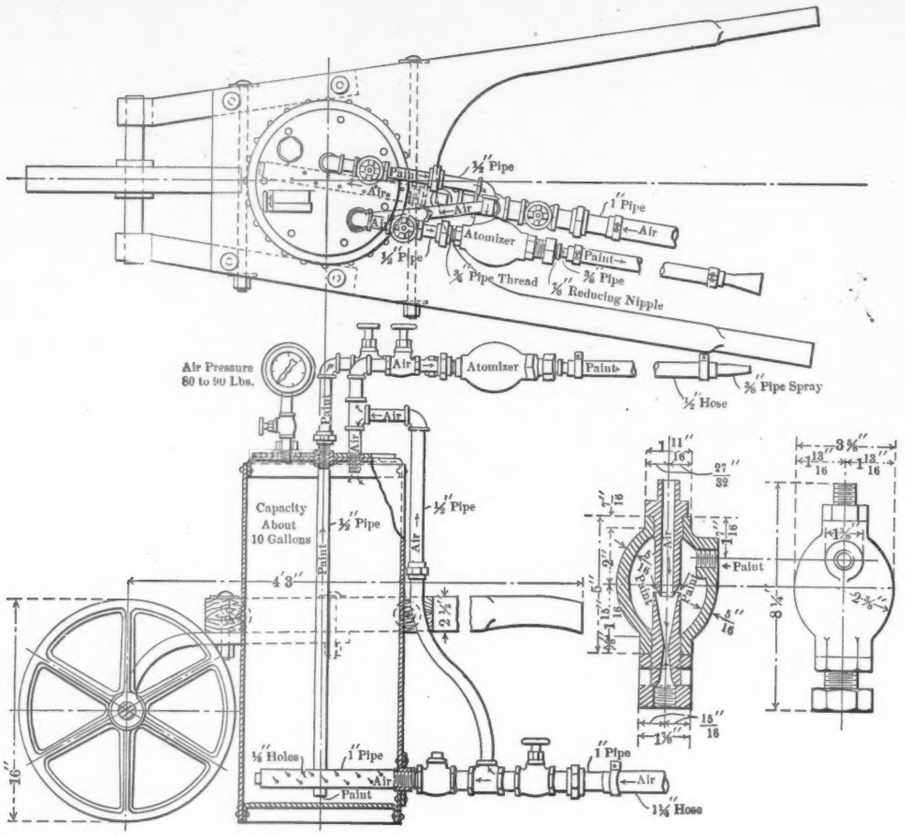


FIG. 42.—DETAILS OF PAINT SPRAYING MACHINE.

much paint is required with a spraying machine as by hand and the car can be painted in about one-half the time. The paint is also much more uniformly distributed. In painting with a brush, with the class of labor and the rate at which it is usually done, the rivets, bolt heads, etc. on the car pull the paint from the brush; any one who has watched the painting of freight cars will realize how much material is wasted in this way, at the same time detracting from the appearance of the car. Before repainting a car the rust is cleaned off with scrapers and wire brushes. Formerly two coats were used in repainting the steel cars, one of the standard black for use on steel or iron and the other of the standard Pennsylvania freight car color. During the past year or two, however, the cars have been given only one coat of paint, that being the standard freight car color.

The specifications for painting new cars require that all parts where metal is placed on metal, and either riveted or bolted, must be painted before assembling with a lute made by mixing one pound of lamp black with 9 pounds of linseed oil. All surfaces of the underframe and body, where metal is placed on metal, which are not accessible after assembling must be painted before assembling with one coat of black protective paint. After assembling all cracks must be thoroughly filled in with lute and all surfaces, which are accessible, must be painted with two coats of black protective paint after which the outside of the body, side sills and end sills, the bottom of the floor and all exposed parts under the slopes must be painted with a final coat of standard freight car color.

A TEN MILLION POUND TESTING MACHINE.

The structural materials testing laboratory of the U. S. Geological Survey is having built, by Tinius Olsen & Co., of Philadelphia, a compression testing machine having a capacity of 10,000,000 pounds.

This machine will be capable of testing full size structures measuring 65 ft. high and having a section of 6 x 6 ft. This would easily take in a full sized structural steel part larger than was the chord which failed in the Quebec bridge.

The machine is a large verticle hydraulic press with one adjustable head and a weighing system which will record loads of 100 pounds on the regular beam, and smaller sub-divisions by means of an additional needle beam. It consists of a base containing the main hydraulic cylinder which has an effecive area of about 2,000 sq. in. upon which rests the lower head with a ball and socket bearing. The upper head is adjustable, through four vertical screws, 13½ in. in diameter and 72 ft. 2 in. long, by means of gearing operating four nuts provided with ball bearings. This head operating mechanism is controlled by the same motor which operates the compressor pump. The great length of the main screws necessitated splicing, which is accomplished as follows: In the center of the screw at the splice is a 3 in. threaded pin for the purpose of centering, the splice being made by means of long split sleeve nuts, which can be removed when it is necessary to lower the upper head below this point.

The hydraulic pressure is obtained from a triple plunger pump operated by means of a 15 h. p. variable speed motor. A needle valve is provided, which permits a constant load to be maintained on the compression cylinder.

The weighing device consists of a set of standard Olsen levers upon which is weighed 1-80 of the total load on the main cylinder, the reduction being effected through the medium of a small piston and diaphragm, the main cylinder having a diameter of 50 in. and the weighing cylinder of 5 9-16 in.

The main cylinder has a vertical movement of 24 in. and the upper head can be operated for adjustment at a speed of 10 in. per minute. The speed in applying loads varies from a minimum of 1-60 in. per minute to a maximum of ½ in. per minute. The contract provides that the machine shall have an accuracy of at least ⅓ of 1 per cent. for any load over 100,000 pounds up to its capacity.

The steam when skilfully made by the fireman must be skilfully and economically distributed in the cylinders if we wish to get power and speed from the steam for moving the train.

DATA OF SPECIAL INTEREST TO THE DRAFTING ROOM.

HELICAL SPRINGS.

Outside Dia. of Coil	3/8" Steel		7/16" Steel		1/2" Steel		9/16" Steel		5/8" Steel		11/16" Steel		3/4" Steel		13/16" Steel		7/8" Steel		15/16" Steel	
	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free
2	1.020	1.38	1.680	1.26	2.600	1.18														
2¼	883	1.50	1.450	1.35	2.250	1.25	3.300	1.18												
2½	780	1.64	1.270	1.44	1.970	1.32	2.900	1.24	4.100	1.18										
2¾	698	1.80	1.140	1.56	1.750	1.41	2.550	1.30	3.600	1.23	4.900	1.18								
3	631	1.98	1.030	1.68	1.580	1.50	2.300	1.37	3.200	1.29	4.400	1.23	5.900	1.18						
3¼	.....	.....	935	1.83	1.430	1.61	2.100	1.46	2.900	1.36	4.000	1.28	5.300	1.22	6.900	1.18				
3½	.....	.....	858	1.98	1.310	1.72	1.910	1.54	2.650	1.42	3.600	1.33	4.800	1.27	6.300	1.22	8.000	1.18		
3¾	.....	.....	.....	.....	1.210	1.85	1.760	1.64	2.450	1.50	3.300	1.40	4.400	1.32	5.800	1.26	7.300	1.22	9.200	1.18
4	.....	.....	.....	.....	1.130	1.98	1.630	1.75	2.300	1.58	3.100	1.46	4.100	1.38	5.300	1.31	6.700	1.25	8.500	1.21
4¼	.....						1.520	1.86	2.100	1.67	2.850	1.54	3.800	1.44	4.900	1.36	6.200	1.30	7.800	1.25
4½	.....						1.420	1.98	1.980	1.77	2.650	1.61	3.500	1.50	4.600	1.41	5.800	1.34	7.300	1.29
4¾	.....						.....	.....	1.860	1.87	2.500	1.70	3.300	1.57	4.300	1.47	5.400	1.39	6.800	1.33
5	.....						.....	.....	1.760	1.98	2.350	1.79	3.100	1.64	4.000	1.53	5.100	1.44	6.400	1.38
5¼	.....						.....	.....	.....	.....	2.250	1.88	2.950	1.72	3.800	1.59	4.800	1.50	6.000	1.42
5½	.....						.....	.....	.....	.....	2.100	1.98	2.800	1.80	3.600	1.67	4.600	1.55	5.700	1.47
5¾	.....						.....	.....	.....	.....	.....	.....	2.700	1.89	3.400	1.74	4.300	1.62	5.400	1.53
6	.....						.....	.....	.....	.....	.....	.....	2.550	1.98	3.300	1.81	4.100	1.69	5.100	1.58
6½	.....						.....	.....	.....	.....	.....	.....	.....	.....	3.000	1.98	3.800	1.83	4.700	1.71
7	.....						.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.400	1.98	4.300	1.84
7½	.....						.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.900	1.98

FORMULA USED IN COMPUTING TABLE

$$P = \frac{S \pi d^3}{16\, r}$$

P = load at solid height
S = fibre stress — 80,000#
d = diameter of steel
r = radius of center of coil

Outside Dia. of Coil	1" Steel		1 1/16" Steel		1 1/8" Steel		1 3/16" Steel			1 1/4" Steel		1 5/16" Steel		1 3/8" Steel		1 7/16" Steel		1 1/2" Steel	
	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free		Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free	Load Solid	Hg't Free
4	10.500	1.18																	
4¼	9.700	1.21	11.800	1.18															
4½	9 000	1.25	10.900	1.21	13.300	1.18													
4¾	8.400	1.28	10.200	1.24	12.400	1.21	14.800	1.18											
5	7.900	1.32	9.500	1.28	11.600	1.24	13.800	1.21		16.400	1.18								
5¼	7.400	1.36	8.900	1.31	10.900	1.27	13.000	1.23		15.300	1.21	18.000	1.18						
5½	7.000	1.41	8.400	1.35	10.300	1.30	12.200	1.26		14.500	1.23	16.900	1.20	19.800	1.18				
5¾	6.600	1.45	8.000	1.39	9.700	1.34	11.500	1.30		13.700	1.26	16.000	1.23	18.700	1.20	21.700	1.18		
6	6.300	1.50	7.600	1.43	9.200	1.37	10.900	1.33		12.900	1.29	15.100	1.26	17.600	1.23	20.400	1.20	23.600	1.18
6½	5.700	1.61	6.900	1.52	8.300	1.46	9.900	1.40		11.700	1.36	13.700	1.31	16.000	1.28	18.500	1.25	21.200	1.22
7	5.200	1.72	6.300	1.63	7.600	1.54	9.000	1.48		10.700	1.42	12.500	1.38	14.600	1.33	16.800	1.30	19.300	1.27
7½	4.800	1.85	5.800	1.73	7.000	1.64	8.300	1.56		9.800	1.50	11.500	1.45	13.400	1.40	15.400	1.36	17.700	1.32
8	4.500	1.98	5.400	1.85	6.500	1.75	7.700	1.66		9.100	1.58	10.600	1.52	12.400	1.46	14.200	1.42	16.300	1.38
8½	.....	.....	5.000	1.98	6.100	1.86	7.200	1.76		8.500	1.67	9.900	1.60	11.500	1.54	13.200	1.48	15.200	1.44
9	.....	.....	.....	.....	5.700	1.98	6.700	1.87		7.900	1.77	9.200	1.69	10.700	1.61	12.300	1.55	14.200	1.50
9½	.....	.....	.....	.....	.....	.....	6.300	1.98		7.400	1.87	8.600	1.78	10.100	1.70	11.600	1.63	13.300	1.57
10	.....	.....	.....	.....	.....	.....	.....	.....		7.000	1.98	8.200	1.88	9.500	1.79	10.900	1.71	12.500	1.64

(From the American Locomotive Company's Standard Practice.)

Calculations.

In obtaining the net static load, the actual weights of the parts constituting dead load, such as wheels, axles, boxes, etc., should be deducted instead of taking a certain arbitrary percentage.

Maximum fibre stress allowable 80,000 pounds, when springs are solid. The figures given in the table in the "Load" column are the calculated loads which will bring springs solid at 80,000 pounds fibre stress.

It is advisable usually to make the capacity of springs slightly more than the net actual load, as given below.

The static load for helical springs must not exceed one-half the load required to bring the springs solid.

Required Capacity.

Driving and Engine Truck Springs: Use calculated static load plus 500 to 1,000 pounds, or about 5 per cent.

Trailing Springs: Use calculated static load plus 15 per cent.

Tender Springs: Use calculated static load taken with three-quarters of maximum load of coal and water.

Spring Tables for helical springs give the capacity or load, for all heights, when spring is solid; the height free is per one inch of solid height.

PISTON THRUST.

CYLINDER.		BOILER PRESSURE--Pounds							
DIAMETER	AREA	150	160	170	180	190	200	210	220
17"	226.98	34050	36320	38590	40860	43130	45400	47670	49940
17½"	240.53	36075	38475	40885	43285	45690	48095	50505	52905
18"	254.47	38175	40720	43265	45810	48355	50900	53445	55995
18½"	268.80	40320	43008	45695	48385	51075	53760	56450	59135
19"	283.53	42525	45360	48195	51030	53865	56700	59535	62370
19½"	298.65	44790	47775	50760	53745	56730	59720	62705	65690
20"	314.16	47130	50270	53415	56555	59700	62840	65985	69120
20½"	330.06	49500	52800	56100	59400	62700	66000	69300	72600
21"	346.36	51960	55425	58890	62350	65815	69280	72740	76210
21½"	363.05	54450	58080	61710	65340	68970	72600	76230	79860
22"	380.13	57000	60800	64600	68400	72200	76000	79800	83600
22½"	397.61	59635	63615	67590	71570	75540	79520	83490	87470
23"	415.48	62320	66480	70630	74790	78950	83100	87250	91410
23½"	433.74	65050	69390	73730	78070	82400	86740	91060	95420
24"	452.39	67860	72380	76910	81430	85950	90480	95000	99530
24½"	471.44	70710	75420	80130	84850	89570	84270	98990	103630
25"	490.87	73630	78540	83450	88360	93270	98180	103080	108000
25½"	510.71	76600	81710	86810	91920	97030	102130	107240	112350